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15000 West 64th Avenue
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STAPLETON INTERNATIONAL AIRPORT
*
GROUND WATER INVESTIGATION
*
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

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PROPOSED EXPANSION PLANS FOR STAPLETON AIRPORT INVOLVE THE CONSTRUCTION OF A NEW TEMPORARY EAST-WEST RUNWAY LOCATED ON THE SOUTHERN TIER (SECTIONS 7,8,11,12) OF RMA. THE PURPOSE OF THIS INVESTIGATION WAS TO LOCATE, IDENTIFY, AND ANALYZE THE ALLUVIAL GROUND WATER SYSTEM BENEATH THE PROJECT SITE AND TO IDENTIFY ANY POTENTIAL GROUND WATER PROBLEMS IN THE VICINITY OF THE TWO RUNWAY ALIGNMENTS. THE GROUND WATER RIGHTS WERE ALSO INVESTIGATED TO DETERMINE THEIR EFFECT ON THE PROPOSED CONSTRUCTION.

THE WORK INCLUDED A REVIEW AND STUDY OF ALL AVAILABLE LITERATURE PERTAINING TO THE ALLUVIAL GROUND WATER SYSTEM. FIELD WORK INCLUDED CONSTRUCTING 46 NEW WELLS AND MONITORING THEIR WATER LEVELS. THE RESULTS OF THE INVESTIGATION ARE PRESENTED ON MAPS SHOWING THE EXISTING CONFIGURATION OF THE ALLUVIAL GROUND WATER TABLE AND BEDROCK. THIS DATA PROVIDES THE BASIS FOR THE CONCLUSIONS AND RECOMMENDATIONS.

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1.0 INTRODUCTION

Stapleton International Airport is located in the northeast portion of the City of Denver, Colorado, and adjoins the southwestern extent of the Rocky Mountain Arsenal (Figure 1). Expansion of the existing runway facilities has been proposed to alleviate flight congestion problems until the construction of a new airport is completed. The new airport, which is proposed to be located northeast of the current airport, is envisioned to be operational about 1995.

Currently, proposed expansion plans involve the construction of a new temporary east-west runway facility located on the southern tier of the Rocky Mountain Arsenal. The property contemplated for construction is located in Sections 11 and 12, Township 3 South, Range 67 West and Sections 7 and 8, Township 3 South, Range 66 West. Two alignments have been conceptualized for the new east-west runway and are designated the Northern Alignment and Alignment C. The locations of the two conceptualized alignments are shown on Figures 16 and 17 with the present alluvial water table configuration.

1.1 Purpose

The purpose of this investigation was to locate, identify and analyze the alluvial (shallow) ground water system beneath the project site, and to identify any potential ground water problems areas in the vicnity of the two conceptualized runway

alignments. The system identification will provide the data base for the design of temporary or permanent dewatering should final design of the runway facilities dictate lowering of the water table during or following construction.

Secondly, ground water rights were to be investigated to determine their effect on the proposed construction and water availability for construction and future use.

1.2 Scope of Work

The work included a review and study of all available literature pertaining to the alluvial ground water system in the vicinity of the project site including information on file with the Rocky Mountain Resource Information (RIC) Center, the U. S. Geological Survey, the Colorado Department of Water Resources and Blatchley Associates, Inc. (BAI) proprietary files. Field work included the siting, design, drilling, construction, testing and monitoring of 46 new water level monitor holes completed in the alluvial aquifer underlying the southern tier of the Rocky Mountain Arsenal.

The results of the investigations are presented on maps showing the existing configuration of the alluvial ground water table and bedrock beneath the project site. This data provides the basis for the conclusions and recommendations.

The analysis of the alluvial ground water system underlying the project site and the effects that runway construction might

have on that ground water system was originally envisioned to require a numerical computer ground water simulation (model). However, review of the conceptual runway alignments and feasibility design after the investigations, it was determined that complete modeling was not warranted at this time. One exception may arise if temporary dewatering for construction of surface drainage structures beneath the runway alignments is required. It was mutually decided by Centennial Engineering, Inc., the prime consultant on this phase of the project, and BAI that full computer modeling of the ground water system was not warranted at this time. In the eventuality that the final runway design indicates that dewatering is required and computer modeling is necessary to properly evaluate the effects of that dewatering on the regional alluvial ground water system, the required modeling input data, including hydraulic conductivity (permeability), amount of ground water inflow onto project lands and aquifer recharge were evaluated.

The work also included an evaluation of the need for dewatering should a grade separated structure be constructed to allow the existing Union Pacific Railroad spur to pass beneath either the western end of the Northern Alignment connecting taxiway or the western end of Alignment C. The existing railroad spur is located east of the existing north-south runway in Section 10, Township 3 South, Range 67 West.

The potential effect of future suburban and commercial development on the alluvial ground water system underlying the project site is also addressed.

The existence of ground water appropriations was to be identified to allow for any modification to the proposed runway project to prevent injury to vested water rights. Water rights not yet appropriated were also to be identified to insure that the resource is not lost because of the proposed construction program.

2.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusions-Existing Ground Water Conditions

(1) Subsurface soils types over the project site are very erratic. The alluvial deposits underlying the site generally consist of interbedded silts, clays, sands and gravels with varying hydraulic character.

(2) The thickness of the alluvial deposits ranges from 5 to 97 feet across the site. The thinnest deposits are located in the eastern portions of the site in the vicinity of a bedrock high located in Section 7. The thickest deposits coincide with a buried stream channel system identified in the western portions of the site, Sections 11 and 12.

(3) The Denver formation is the uppermost bedrock unit underlying the alluvial deposits throughout the project site. Although beneath some areas of the site, permeable sandstone layers within the Denver formation were found to be in contact with the overlying alluvium, they did not appear to be water bearing, i.e., the Denver formation aquifer does not appear to be contributing water to the overlying alluvium within the confines of the project site.

(4) Numerous relatively impermeable layers of material, clays and sandy clays exist within the alluvial deposits beneath the site. These relatively impermeable layers of material result in

confined water table conditions existing in the alluvial aquifer in some areas of the site. Unconfined water table conditions exist in other portions of the site where these impermeable layers of material are absent but also exist in some areas where they are present.

(5) Although the layers of relatively impermeable material within the alluvium result in confined water table conditions beneath some areas of the site, they are apparently discontinuous throughout the entire project site and do not separate the ground water contained in the alluvium into two distinct aquifer zones. There is only one water table surface across the site at present, which indicates a direct hydraulic connection of the ground water above and below these layers of relatively impermeable material.

(6) The relatively impermeable layers of material also result in and provide the potential for both the long term and intermittent perching of ground water above the water table. Only one area within the project site was identified where ground water was being intermittently perched above the water table. Other areas may exist. The intermittent perching of water near the surface has been reported in the eastern portions of the site by Rocky Mountain Arsenal personnel.

(7) In areas where the water table is confined below relatively impermeable layers of material within the alluvium, penetration of the confining layer(s) will result in a rise of the water table to a level equal to the potentiometric pressure

of the confined water. Localized high ground water problem areas may require temporary dewatering for construction.

(8) The configuration of water table has not changed significantly in the past twenty-eight years although its elevation may have. The general water table gradient across the site is to the northwest towards the South Platte River. The bedrock high in the eastern portions of the site imparts a more northern direction to the flow of the ground water on the eastern end of the site.

(9) Recharge to the alluvial aquifer is primarily from precipitation and the inflow of ground water from the south and southeast. The aquifer also receives both continual and intermittent recharge from on-site and near-site sources including seepage from First Creek, the High Line Lateral, and the storm drain intercepter systems that cross the property, i.e., the Havana Street Interceptor, Havana Street Lakes, Joliet and Uvalda Street Interceptors and others, and the lakes located immediately north of the project site, i.e., the "South Lakes."

(10) Approximately eleven million gallons per day of ground water is presently entering the project site. The majority of the ground water entering the project site is through the buried channels in the western portions of the site.

(11) Comparison of the existing elevations of the water table in the vicinity of the two conceptualized east-west runway

alignments with the maximum expected excavation elevations, indicates that large scale dewatering to lower the water table will not be required for the runways.

(12) Temporary dewatering during construction may be required at the western end of the Northern Alignment and the extreme eastern end of Alignment C. Temporary dewatering may also be required where each of the runway alignments cross the Uvalda Street Interceptor system ditch and the Northern Alignment crossing the High Line Lateral.

(13) Permanent or temporary dewatering to lower the water table in the vicinity of the Union Pacific Railroad spur crossing the western end of the Northern Alignment connecting taxiway and the western end of Alignment C will be required if a grade separated structure is constructed to pass the spur beneath the taxiway or runway.

(14) Alignment C appears to be the more favorable of the two conceptualized runway alignments from the ground water standpoint. The water table generally underlies Alignment C at greater depths than along the Northern Alignment. Alignment C would not cross any of the known areas of contamination identified on the project site.

2.2 Conclusions-Future Ground Water Conditions

1. The elevations of the alluvial water table underlying the site will fluctuate seasonally. Depending upon the magnitude

of this fluctuation and the final runway alignment, the need for dewatering may have to be re-evaluated.

2. The construction of new runway facilities will result in increased and concentrated amounts of precipitation runoff contributing to the ground water system. The result may be a localized rise in the water table or the creation of problem areas where water is mounded above the water table by relatively impermeable layers of material within the alluvium.

3. If landscape irrigation along the course of the new runway facilities is conducted, subsurface return flows from such irrigation may result in a localized rise in the water table and/or be mounded above the water table on layers of relatively impermeable material causing the creation of high ground water problem areas.

4. If the development of off-site properties situated in an up-gradient direction of the water table, south and southeast, occurs within the life span of the runway facilities, increased or concentrated amounts of surface runoff and subsurface return flows from landscape irrigation may adversely impact the alluvial ground water system underlying the project site. The potential impacts from off-site development are addressed in Subsection 5.1.9 of this report.

2.3 Conclusions-Ground Water Rights

1. Water rights to two shallow wells on the Southern Tier are in the process of being adjudicated in the Division 1 Water

Court. These wells and associated water rights should not be injured by either the Northern Alignment or Alignment C.

2. Shallow alluvial water is abundant within the boundary of the Southern Tier and available for appropriation; however, a plan for augmentation would be required concurrently with the appropriation of this water. The alluvial ground water is tributary to the South Platte River system.

3. No appropriations of the nontributary and not nontributary water available from the underlying Denver Basin bedrock aquifers have been made by the Rocky Mountain Arsenal on the Southern Tier. Some appropriation of these waters have been made by adjoining property owners. The remaining nontributary and not nontributary water supplies are subject to the New Rules and Regulations of the Denver Basin established under Senate Bill 5. Water supplies should be available to the present owners at the rate of 1,981.0 acre-feet per year from the bedrock aquifers.

2.4 Recommendations

1. The ongoing monitoring of water levels should be continued to establish the magnitude of the seasonal fluctuation of the water table. Once established, the need for dewatering in the vicinity of the new runway facilities should be re-evaluated.

2. During the final subsurface drilling for the design phase of the selected east-west runway alignment, special attention should be paid in the identification of all substantial

layers of clay and sandy clay material that could create confined or perched water table conditions.

3. All test holes for the design phase should be completed as water level monitor holes. Additional water level monitor holes should be installed where local conditions warrant their placement.

4. If a grade separated structure is required to allow the passage of the Union Pacific Railroad spur beneath the new east-west runway facilities, a site specific study should be conducted to determine the type of dewatering required, permanent or temporary. Computer modeling may be necessary during this study to determine the effects on the regional ground water system should dewatering be proposed at these sites.

5. Prior to final design of the new runway facilities, the preliminary design plans should be reviewed by an experienced ground water hydrologist to determine if dewatering requirements have changed.

6. A properly designed storm drain system should be incorporated into the runway and taxiway designs. The water collected should be disposed of away from the runway facilities, preferably through existing drainage structures that convey off-site storm runoff flows to the "South Lakes" located immediately north of the project site.

7. Landscape irrigation along the new runway facilities should be kept to a minimum. If irrigation is used, efficient

irrigation practices should be observed to minimize the potential for the creation of ground water problem areas due to subsurface return flow of the applied irrigation water.

8. The future development of off-site properties located in an up-gradient direction of the water table, south and southeast of the project site, should be monitored closely. If development occurs within the life span of the runway facilities, adverse impacts to the shallow ground water system, as addressed in Subsection 5.1.9 of this report, may occur from increased runoff and subsurface return flows from applied irrigation water. Computer modeling of the regional ground water system may be required to determine the magnitude of these potential effects.

9. The purchase documents for land for any runway should recognize the value of the available ground water supplies.

3.0 DRILLING AND CONSTRUCTION OF TEST/MONITOR HOLES

To obtain accurate up-to-date information on subsurface soil conditions (type of material and depth to bedrock), water table elevations and aquifer parameters, a total of 46 new test/monitor holes were installed at 34 different locations across the project site (Figure 2, Test/Monitor Hole Location Map). Each of the water level monitor holes were constructed in test borings first utilized by Chen and Associates, Inc. for subsurface soil sampling and testing. Following completion of soil sampling, each of the Chen borings was completed for use as a water level monitor hole or permeability test hole (T/M Hole).

The 46 test/monitor holes were drilled and constructed during the period April 24, 1985, to June 24, 1985. The drilling was performed by Geotechnic Exploration Company of Denver, Colorado, utilizing a truck-mounted C.M.E. Model 55 rig. The drilling utilized 4-inch continuous flight augers and 6, 7 and 8-inch diameter hollow augers. The type of material encountered during drilling is shown on the Logs of Test/Monitor Holes, Figures 3, 4 and 5.

The drilling and construction of the 46 test/monitor holes took place in six phases. The locations of all the test/monitor holes drilled and completed during the six phases are shown on Figure 2, Test/Monitor Hole Location Map. The first phase of drilling and construction involved the drilling of all test/monitor holes to bedrock or fully penetrating the alluvial

aquifer. The intended use of the Phase 1 test/monitor holes was three-fold (1) to identify the depth to bedrock, (2) to determine the saturated thickness of the alluvial aquifer, and (3) to allow for initial and periodic measurement of the depth to the water table. All Phase 1 test/monitor holes were completed using similar techniques. The construction details are shown in Figure 6, Typical Construction Details Phase 1 and 2 Test/Monitor Holes. Hand-sawn slotted PVC or Fiberglass pipe (slotted from the top of the water table to bedrock), with a 2.0 to 5.5-foot plain section of pipe and a bottom cap (Sump) was then placed in the borehole and completed at the surface with a 4 to 10-foot bentonite surface seal and a vented top cap.

The Phase 2 drilling and construction of test monitor holes was originally planned to involve the drilling and completion of test/monitor holes that would be used solely for soil sampling and water level measurements. As such, it was not anticipated that the Phase 2 test/monitor holes would need to be completed to bedrock. This depth limitation was conditioned on the Phase 1 results that if the actual depth to bedrock identified during Phase 1 drilling was within 10 percent agreement with the published information on the depth to bedrock beneath the project site, the Phase 2 test/monitor holes were to be completed to a minimum of ten feet below the top of the water table. This criteria, however, was not met by the majority of the Phase 1 test/monitor holes so all of the Phase 2 test/monitor holes were drilled and completed to bedrock. The construction details of

the Phase 2 test/monitor holes are, therefore, the same as the Phase 1 test/monitor holes as shown in Figure 6.

Phase 3 test/monitor holes were drilled and completed for an additional purpose other than their use for soil sampling and water level measurements. Each was completed to fully penetrate the aquifer and constructed to allow permeability testing of the alluvial aquifer. Working under the constraint that water could not be injected into or withdrawn from the aquifer during testing, due to potential contamination problems, neither falling head, packer, or pump tests could be performed to determine the permeability of the aquifer. With these constraints, each of the Phase 3 holes was designed and completed to facilitate permeability testing utilizing displacement slug testing techniques. The typical construction details for the Phase 3 holes are shown in Figure 7, Typical Construction Details, Phase 3 Test/Monitor Holes. Each was completed with continuous slot PVC well screens and gravel pack sized to retain 80 to 90 percent of the formation. Well screens and gravel pack designed to retain this percent range of the formation were utilized to avoid removing disproportional amounts of the fine faction of the formation. It was felt that removal of substantial amounts of fines from the formation would result in unrepresentative permeability values calculated for the in-place formation material.

Following the first three phases of test/monitor hole drilling and construction, a series of shallow test/monitor holes

were installed to investigate areas where perched water table conditions were suspected. The Phase 4 test/monitor holes were installed in areas in close proximity to the two conceptualized runway alignments where relatively substantial impermeable or low permeability layers of material were encountered during initial phases of drilling. Essentially the same construction techniques utilized during the first two phases of test/monitor hole completion were employed on the Phase 4 holes, the only difference being that they were completed at the top of the impermeable layer suspected to be causing perched water. The typical construction details are shown in Figure 8, Typical Construction Details Phase 4 Test/Monitor Holes. In the vicinity of Phase 1 T/M Hole 11-1, the existence or potential for perched water table conditions was investigated by utilizing a dual completion test/monitor hole. In the vicinity of Phase 2 T/M Holes 12-6 and 7-1, dual completion test/monitor holes were also utilized to investigate two different suspected perched water zones. The construction of the dual completed test/monitor holes are shown on the construction summaries of each test/monitor hole in Appendix A.

Review of figures presenting typical construction details of the test/monitor holes completed during the first four phases of drilling and the construction summaries contained in Appendix A will reveal that several of the test/monitor holes were completed with Expoy Fiberglass Resin pipe. Although water quality sampling was not included in the scope of our work and was not

permitted by the Rocky Mountain Arsenal at the time of our investigations, the fiberglass pipe, whose inert qualities have been E.P.A. certified, was utilized to provide the ability to obtain respresentative water samples if required at some future date.

The two test/monitor holes completed during Phase 5 of drilling (T/M Holes 11-5 and 12-5) and the two test/monitor holes done during Phase 6 (T/M Holes 10-1 and 10-2) were done to investigate the subsurface soil conditions in areas where Chen and Associates required additional data. T/M Holes 11-5 and 12-5 were drilled in the vicinity of pre-existing observation holes which provided depth to bedrock information and were being utilized for water level measurements. Although these test/monitor holes were completed as monitor holes, water level measurements are not being taken or incorporated in this study.

T/M Holes 10-1 and 10-2 were drilled and completed in the vicinity of the Union Pacific Railroad spur located immediately west of the southern tier in Section 10. These test/monitor holes were installed to investigate the soil and ground water conditions in the area where a grade separated structure is conceptualized to allow the railroad spur to pass beneath the western end of the Northern Alignment connecting taxiway or the western end of runway Alignment C. Each test/monitor hole was completed as a water level monitor hole and water level measurements are being taken and incorporated in this study.

The as-built details of the Phase 5 and 6 hole are shown in Appendix A.

An additional 15 pre-existing alluvial monitor holes were also incorporated into this study. These 15 monitor holes were drilled and completed for previous studies on and in the immediate vicinity of the project site. The location of these 15 previously completed monitor holes are shown on Figure 2.

Following completion of the new test/monitor holes, the water levels in the new and the majority of the pre-existing monitor holes were monitored weekly for one month. The changes in water levels were carefully observed and tabulated and once the water levels had stabilized somewhat, they were incorporated in our overall analysis. Water level monitoring is continuing on a monthly basis to ascertain the magnitude of the seasonal fluctuation of the water table.

4.0 RESULTS OF GROUND WATER INVESTIGATION

4.1 General Results Over Entire Site

4.1.1 The Alluvial Deposits

Analysis of the boring logs of the newly completed test/monitor holes and the pre-existing monitor holes indicates that the alluvium underlying the project site is comprised of 5 to 97 feet of interbedded silts, clays, sands and gravels. The individual layers of material, ranging in thickness from a few inches to several tens of feet, are lenticular in nature and grade laterally over short distances into differing lithologies. Detailed descriptions of the types of alluvial material encountered during drilling on the project site are presented on Figures 3, 4 and 5, Logs of Test/Monitor Holes. As shown on the logs of the test/monitor holes (T/M Hole) of particular significance are the numerous clay and sandy-clay layers identified during drilling. The importance of these less permeable or impermeable layers of material in the alluvial ground water system underlying the site is addressed later in this section of the report.

The minimum and maximum thickness of alluvium found during drilling on the project site was 5 feet (T/M Hole 7-3) and 97 feet (T/M Hole 11-1). The thinnest alluvial deposits are located in the vicinity of a bedrock high located in Section 7 and the thickest deposits are located within buried stream channels

situated in Section 11 and 12. The location of the bedrock high and the buried channels are shown on Figure 9, Depth to Bedrock Contour Map; Figure 10, Bedrock Contour Map and Figure 11, Three Dimensional Bedrock Surface Block Diagram.

4.1.2 The Denver Formation

The Denver formation is the uppermost bedrock unit underlying the surficial alluvium throughout the entire project site. As mentioned above, the Denver formation is covered by 5 to 97 feet of alluvium across the site. A small outcrop of the Denver formation was located approximately 70 feet west of T/M Hole 7-3 in the area of the bedrock high in Section 7. Figures 9 and 10 are bedrock contour maps drawn on the depth to and elevation of the top of the Denver formation. Figure 11 is a three dimensional representation of the configuration of the bedrock underlying the project site as viewed from the southwest corner of the site near T/M Holes 10-1 and 10-2. As shown on the logs of the test/monitor holes, Figures 3, 4 and 5, the bedrock encountered during drilling consisted primarily of clay shales. Sandstone layers within the Denver formation were also encountered in several of the test/monitor holes completed in Section 11. The majority of the sandstone layers encountered were relatively thin and appeared to be lenticular in nature as they were not correlatable across the site. None of the sandstone lenses appeared to be water bearing. A zone of hard, black coal was also encountered within the Denver formation in T/M Holes 8-3 and 8-4 located in the northeastern portions of Section 8.

4.1.3 The Alluvial Aquifer Conditions

Lithologic and long-term water level data obtained from the new test/monitor holes and the pre-existing monitor holes completed in the alluvium indicate that the hydrologic conditions of the alluvial ground water system beneath the project site are quite variable and controlled in part by the complex interbedded lithology of the alluvium and in part by the variable amount of recharge contributed to the aquifer.

The presence of the numerous less permeable or impermeable layers of clay and sandy-clay material identified within the alluvium are one of the primary lithologic variables controlling the flow of ground water within the alluvial ground water system underlying the site. Other controlling factors inherent to the complex lithology of the alluvium include varying permeability and transmissivity. The importance of these clay and sandy-clay layers lies in the fact that they are relatively impermeable and as such do not generally allow the passage of significant amounts of water. Their effect on the alluvial ground water system are two-fold:

1. In some of the areas where present, the clay and sandy clay layers result in localized confined water table conditions, i.e., the water table is confined or held down below the layer(s) of relatively impermeable material.

2. The clay and sandy clay layers provide the potential for long term or intermittent perching of ground water above the alluvial water table.

Although the existence of these relatively impermeable layers result in confined water table conditions beneath some areas of the site, unconfined conditions are exhibited in other areas where these impermeable layers are present. Unconfined conditions are also found to exist in other areas of the site where these clay and sandy-clay layers are absent. An example of confined conditions resulting from the presence of impermeable layers can be seen when examining the log of T/M Hole 11-4A. During drilling, water was encountered at a depth of approximately 21 feet below ground level, just below a clay layer encountered from 17.5 to 21 feet. Upon completion, the water level was measured to be 14.5 feet below ground level. The water level had risen 6.5 feet to a level above the confining layer. Evidence of unconfined conditions in areas where substantial clay and sandy-clay layers are present is shown on the logs of T/M Holes 12-6 and 12-6A. Water level measurements indicate essentially the same water levels in each of these T/M holes even though T/M Hole 12-6 is completed through a substantial clay layer penetrated from 31 to 43 feet and T/M Hole 12-6A is completed above this same layer. Apparently, due to the lenticular nature of the clay and sandy-clay layers, there is direct hydraulic connection between the waters above and below impermeable layers in some areas of the site.

4.1.4 The Practical Effect of Clay Layers on the Water Table

In lieu of the confined water table conditions exhibited in some portions of the site and unconfined in others, the water table contour maps depict the configuration of an alluvial water table assuming that the confining layers were not present. It is a more valid representation of the actual ground water conditions than mapping the confined (below relatively impermeable layer) water elevation or depth from surface. Mapping the depth to and/or the elevation of the upper surface of the confined ground water would result in a deceptive picture of the configuration of the water table, especially in areas located in the future where there may be no significant layers of impermeable material and the water is unconfined.

The second important effect that the relatively impermeable layers of clay and sandy-clay have on the alluvial ground water system is the perching of ground water. Perched ground water has a more significant effect in creating potential problems than the confined and unconfined water table conditions previously discussed. To ascertain the existence of, or the potential for, perched water zones within the alluvium, a series of shallow test/monitor holes (Phase 4 test/monitor holes) were drilled and completed in the general areas of the two conceptualized east-west runway alignments. Each was installed in areas where earlier phases of drilling and completion of test/monitor holes indicated that perched water table conditions may exist (see

Test/Monitor Holes Location Map, Figure 2). The majority of the Phase 4 T/M holes did not indicate perching of water was occuring. However, the dual completed T/M Hole 11-1 did indicate that perching of ground water does occur in some areas of the project site. Water level data obtained from T/M Hole 11-1 indicated that the intermittent perching of ground water above relatively impermeable layers of material does occur. T/M Hole 11-1 was dual completed with one column of PVC pipe installed to total depth of the drill hole and one column of PVC pipe installed above a clay layer suspected to be perching water. Initial water level measurement taken in the test/monitor hole completed above the clay layer indicated that the alluvium above the clay layer was dry. Water level measurements taken following a substantial rain indicated water was being perched above the clay layer. Measurement taken approximately one month later indicated the perched water had drained off and the alluvium was again dry.

Even though perched water table conditions were only documented in one area of the project site, it should be kept in mind that this is based on widely spaced lithologic and water level data. Other zones of perched water <u>may exist</u>. Areas of temporary ponds and/or near surface ground water have been reported in the eastern portions of the project site by Rocky Mountain Arsenal personnel. Special attention should be paid to the identification of any substantial layers of relatively impermeable material, clay and sandy clays, encountered during final phases of drilling on the east-west runway alignment chosen to be

constructed. Permanent or temporary dewatering in areas of perched water may be required in order to avoid adversely impacting runway facilities. The potential for creating shallow ground water problem areas as a by-product of storm drainage and landscape irrigation should also be carefully considered during the design phase of the runway facilities.

4.1.5 Interconnection of Alluvium and Bedrock

Before addressing the configuration of the alluvial ground water table underlying the project site, a brief discussion of the interconnectivity of the Denver formation (bedrock) and the alluvium is warranted. Previous work conducted in the general area of the project site has reported that in some areas where sandstones within the Denver formation were found to be in contact with the alluvium, that significant amounts of ground water were being contributed to the alluvium. Our initial investigations indicate that this is generally not the case beneath the project site. As previously mentioned, most of the T/M holes encountered shales at the contact with bedrock. Where sandstones layers were encountered, the majority were relatively thin and all appeared to be lenticular in nature as they were not correlatable across the site. None of the sandstones encountered appeared to be contributing ground water to the overlying alluvium. Review of the potentiometric surface map of the Denver aquifer within the Denver Basin, (Robson and Romero, 1981) indicated that the potentiometric surface of the Denver aquifer is

approximately 250 to 350 feet below the existing ground surface across the project site. This is well below the depths at which the permeable sandstones were encountered which would indicate that if flow exists, the flow of ground water is from the alluvium into the Denver formation rather than from the Denver formation into the alluvium.

4.1.6 Present Alluvial Flow Regime

The configuration of the alluvial ground water table at the time of our investigation is presented by the map on Figure 12, The Existing Water Table Elevation. The depth to top of the water table is presented on Figure 13, Existing Depth To Water Table.

The water table gradient across the site is towards the northwest. The elevation of the water table ranges from a high of approximately 5,300 feet in the southeastern portions of the project site, Sections 7 and 8, to a low of 5,210 feet in the northwest corner of the site, Section 11. Some increase in the elevation of the water table beneath the project site has occurred in past years; however, the configuration of the water table has not changed significantly from that published in previous works by others dating back to the 1950's (Smith et al, 1964; Romero and Ward, 1981). The rise in water table elevation and the generally unchanged configuration of the water table can be seen when comparing Figure 12 with Figures 14 and 15 which

depict the elevation and configuration of the water table beneath the project site in 1957 and 1981, respectively. As can be seen when comparing Figures 12 and 15, the elevation of the water table beneath the project site has not changed significantly since 1981. Comparison of Figures 12, 14 and 15, however, indicates that approximately a ten foot rise in the elevation of the water table has occurred across the site since 1957. The upwards fluctuation in the elevation of water table is probably due to increased surface runoff and subsurface return flows from landscape irrigation from off-site developments located south of the Rocky Mountain Arsenal.

Other conditions of significance observed during our investigations were the presence of a bedrock high with an associated area of unsaturated alluvium located in Section 7 and the existence of extensive buried stream channel system located in Sections 11 and 12.

The bedrock high bifurcates the generally northwest-trending flow of alluvial ground water entering the project site beneath Sections 7 and 8 and imparts a more north trending flow direction in eastern portions of the site.

The significance of the buried stream channel system lies in the fact that the primary flow paths of the ground water beneath the site occurs within its confines. The flow of ground water beneath the project site is not limited to the confines of the buried channels. The configuration of the buried channel

system along the northern boundary of the site was defined in previous work by the U. S. Army conducted in 1982. However, the configuration of the channel system in the southern portions of Sections 11 and 12 was not defined until data from this study were analyzed.

The configuration of the bedrock high and buried channel system are shown on Figures 9, 10 and 11. The bifurcation of the flow of ground water entering the southeastern portions of the site can be seen on Figure 12.

4.1.7 Hydrologic Characteristics of the Alluvial Aquifer

In defining the extent of the saturated alluvium and the configuration of the water table beneath the project site, the permeability of the alluvial aquifer was determined to quantify the amount of ground water flow entering the site and to provide needed input if full computer modeling of the alluvial aquifer underlying the project site is required at some future date. Determination of the sources of recharge to the alluvial aquifer and calculations of the amount of recharge were also made.

The most accurate method of determining the permeability or hydraulic conductivity of an aquifer as well as other aquifer parameters such as transmissivity is through the use of long-term continuous rate pump tests. Due to constraints imposed on the investigations, testing of the alluvial aquifer underlying the project site utilizing pump test was not allowed. The injection

of water into the aquifer for determination of permeability through the use of slug testing techniques was also prohibited. Under these constraints, permeability testing of the aquifer was accomplished utilizing slug testing techniques involving the displacement of the in place ground water. As discussed previously, Phase 3 T/M Holes 11-1, 11-4, 12-2, 12-4A and 8-3B were constructed to facilitate this type of slug testing. Each test/monitor hole constructed for slug testing was developed by surging techniques using the natural in place ground water.

An In-Situ, Inc. Model SE1000A hydrologic monitor system incorporating a pressure transducer, was utilized to measure the changes in water level when a known volume of water was introduced or removed from the water in storage via displacement with a section of closed end pipe. The results of each test were tabulated and permeability values calculated using interpretation techniques developed by Hvorslev, 1951, and Bouwer and Rice, 1976. The test results are presented on Table 1. The permeabilities calculated from the slug test were in the 10^{-2} to 10^{-3}cm/sec range. The maximum permeability calculated from the slug tests was 0.18 cm/sec. (509.04 ft/day) in T/M Hole 11-4 located within the buried channel system in Section 11 and the minimum permeability was found to be .0031 cm/sec (8.77 ft/day) in T/M Hole 12-4 located in the vicinity of the bedrock high identified in Section 7. The permeability values calculated from slug tests are only representative of the material close to the point of testing. The permeabilities were found to be highly

variable due to the complex nature of the alluvium, but are within the ranges of permeabilities calculated from other area pump tests conducted in the vicinity of the project site (Blatchley Associates, Inc. 1980; U. S. Army, May 1982).

Utilizing an average permeability value of .0703 cm/sec. (198.81 ft/day) in the western portions of the project site in the vicinity of the buried channel system, a value of .0068 cm/sec (19.23 ft/day) in the eastern portions of the site, the average hydraulic gradients obtained from the water table contour map and the average cross sectional areas perpendicular to the flow, it is estimated that approximately 11 million gallons per day (17 cubic feet per second) of alluvial ground water is presently flowing into the project area. The majority of the flow of ground water entering the project site is along the southern boundaries of Sections 11 and 12 through the buried stream channel system which traverses the western portions of the site in a northwesterly direction.

Recharge to the alluvial aquifer underlying the project site naturally occurs from precipitation, seepage from First Creek and ground water inflow from the south and southeast. The aquifer also receives intermittent and continual recharge from several on or near site sources. Intermittent sources of recharge from on-site sources include seepage from the High Line Lateral, the Havana, Joliet and Uvalda Streets storm drain interceptors, the southern of the two Havana Street Lakes and that

portion of the Sand Creek Lateral used to convey water from the Havana Street interceptor system to the "South Lakes" along the northern boundary of the project site. Sources of continual recharge include the northern of the two Havana Street Lakes and the South Lakes, i.e., Ladora, Upper and Lower Derby Lakes.

An aquifer recharge rate of approximately 0.25 feet per year (0.25 acre feet per acre of land) was estimated which includes precipitation and the intermittent and continual sources of recharge listed above. Due to the intermittent nature of several of these sources of recharge, the amount of recharge calculated is quite variable. The recharge rate of 0.25 feet per year may need refinement or adjustment during model calibration if computer modeling of the alluvial ground water system underlying the project site is required at some future date.

4.2 Results In Immediate Vicinity of Conceptualized East-West Runway Alignments

Two runway alignments have been conceptualized for the east-west runway proposed to be constructed on the project site. The two alignments have been designated the Northern Alignment and Alignment C. The locations of the alignments are shown on Figures 16 and 17. Figure 16 shows the location of the Northern Alignment and Figure 17 Alignment C. The configuration of the water table in the vicinity of each respective runway alignment is also shown on these figures.

All stationing of the proposed alignments refer to Centennial Engineering, Inc. Stationing established as of July 24, 1985.

4.2.1 Northern Alignment-Runway

As can be seen on Figure 16, the elevation of the present water table in the vicinity of the Northern Alignment ranges from a high of approximately 5280 feet at the eastern end of the runway, Station 128+00, to a low of about 5237 feet at the west end of the runway, Station 8+00. The alignment crosses an area of unsaturated alluvium between Station 88+00 and approximately Station 116+00.

The Northern Alignment also traverses an area of known contamination located between approximately Station 24+00 to approximately Station 40+00. The area of known contamination coincides with the Rod and Gun Club pond (Dames and Moore, 1985). The general location of the contaminated area is shown on the Test/Monitor Hole Location Map, Figure 2, and its location in regards to the Northern Alignment is shown on Figure 16.

Examination of the conceptualized construction details of the runway shown on cross-sections provided by Centennial Engineering, Inc. indicates that the water table is below the maximum expected excavation elevation of the runway and taxiway along the entire length of the Northern Alignment. The water table, however, is close to the maximum expected excavation elevation at the western end of the alignment, Station 8+00 to 28+00. The present water table at this end of the alignment is only 1 to 2 feet below the maximum expected excavation elevation.

Dewatering or lowering of the water table, assuming it does not change, will not be required along the Northern Alignment except for possible temporary dewatering during fill placement in the vicinity of the Rod and Gun Club pond and during construction at the western end of the runway where the water table is 1 to 2 feet below the expected excavation elevation, Station 8+00 to Station 28+00. Temporary dewatering may also be required during construction of the drainage structures allowing the intermittent flow in the Uvalda Street Interceptor system ditch and the High Line Lateral to pass beneath the runway. A re-evaluation of the need for temporary dewatering at these locations should be made when the proposed designs of these structures are made available.

4.2.2 Northern Alignment-Taxiways

Further examination of Figure 16 shows that the elevation of the water table in the proximity of the taxiway connecting the Northern Alignment with the existing airport facilities ranges from about 5340 feet where the taxiway connects into the western end of the runway, Station 585+00, to a low of approximately 5225 feet at the connection to the existing north-south runway in Section 10 (Station 500+00).

As during the evaluation of the Northern Alignment, conceptualized construction details depicted on cross-sections along stationing were utilized to evaluate the need for dewatering along the connecting taxiway. The water table was found to be

well below the maximum expected excavation elevation except at Station 584+00 just before the taxiway connects into the western end of the runway. The water table is only 2 feet below the expected excavation elevation on the northern of the two taxiways at Station 584+00 and is at an elevation equivalent to the expected excavation elevation at Station 584+00 on the southern taxiway. Temporary dewatering may be required during construction at this end of the connecting taxiway system. As stated above, the water table is well below the maximum expected excavation elevation along the majority of the connecting taxiway. This is because the taxiway overlies the deepest portions of the old buried stream channel system that underlies the western portions of the project site. In fact, the elevation of the water table along the taxiway is well enough below expected excavation elevations that temporary dewatering should not be required for the construction of the Havana Street Interceptor drainage structure beneath the connecting taxiway.

If the existing Union Pacific Railroad spur crossing the connecting taxiway near Station 516+00 is not rerouted around the new runway facilities, a grade separated structure may be required to allow the railroad spur to pass beneath the taxiway. Depending upon design, permanent or temporary dewatering to lower the water table, if the present elevation persists, will be required as it is expected the invert of the structure will be tens of feet into bedrock and well below the water table.

4.2.3 Alignment C-Runway

The elevation of the water table in the vicinity of Alignment C is shown on Figure 17. The elevation of the water table along the course of this alignment ranges from a high of approximately 5,270 feet at the eastern end of the runway, Station 320+00, to a low of about 5,225 feet at the western end, Station 200+00.

Analyses of the cross-sections depicting conceptualized design of the runway and taxiway along this alignment, assuming the ground water elevations do not change, indicate that the water table is substantially below the maximum expected excavation elevations except near the far eastern end of the taxiway. The elevation of the water table ranges from 21 to 9 feet below the maximum expected excavation elevations along the course of the runway from Station 200+00 to Station 320+00, respectively.

The substantial depth at which the water table underlies the runway along Alignment C precludes the need for any lowering of the water table to construct and/or protect the runway facilities. There may be, however, a need for temporarily lowering the water table where the Uvalda Street Interceptor system ditch will be passed beneath the runway between approximately Station 298+00 and Station 308+00. The present water table is only about 1 to 3 feet below the expected excavation elevations for the two structures anticipated to be constructed.

As is the case with the Northern Alignment connecting taxiway, a grade separated structure may be required to allow the existing Union Pacific Railroad spur to pass beneath Alignment C in the proximity of Station 209+00. Again, depending upon design, permanent or temporary dewatering to lower the water table, if the present elevation persists, will be required as it is expected the invert of the structure will be tens of feet into bedrock and well below the water table.

4.2.4 Alignment C-Taxiways

The present elevation of the water table along the course of the paralleling taxiway ranges from 18 feet below the expected excavation elevation at Station 200+00 to 3 feet below at Station 320+00. Only at the extreme eastern end of the taxiway from Stations 312+00 to 320+s00 is the present water table relatively close, 3 to 5 feet, to the maximum expected excavation elevations.

4.3 Predicted Future Conditions

The construction of the new east-west runway facilities at either the Northern Alignment or Alignment C should not adversely impact the alluvial ground water system beneath the project site. The initial investigations indicate that a permanent lowering of the water table will not be required along either alignment except possibly in the vicinity of the Union Pacific Railroad spur. Generally, the ground water will flow unobstructed by the

runway facilities; hence, continuing its northwestern course to the South Platte River. The potential effects on the alluvial ground water system as a result of constructing a grade separated structure allowing the passage of the railroad spur beneath the Northern Alignment connecting taxiway and Alignment C will depend upon the design and operation of the permanent or temporary dewatering system. Any adopted design for the grade separation should not diminish the quantity of ground water but could alter the ground water flow regime somewhat. These issues should be addressed in a separate site specific study should the grade separation be included as a specific alternative.

Accurate prognostication of future ground water conditions beneath the project site within the life span of the proposed temporary runway facilities is difficult to make without the use of a very sophisticated computer model of the regional ground water system. Even then, the future development assumptions are subject to speculation. Much of the development in the region is already reflected in the ground water systems. However, several factors that may adversely influence the condition of the alluvial ground water system as documented and defined herein should be considered.

The configuration of the alluvial ground water table beneath the project site was determined utilizing water level data obtained over a relatively short period of time, approximately four months. The elevation of the water table beneath any portion of the project site will vary depending upon the time of

year. Water level measurements are continuing to be obtained to determine the magnitude of the seasonal fluctuation of the water table. Once established, the conceptualized or proposed design of the new east-west runway facilities should be re-examined to determine if the seasonal flcutuation of the water table will adversely impact runway and taxiway construction. In lieu of the fact that the water table is sufficiently below the maximum expected excavation elevations along the majority of both runway alternatives, a fairly substantial upward fluctuation of the water table would have to occur to create a problem. This is especially true in the vicinity of Alignment C.

Increased or concentrated amounts of precipitation runoff will occur in the immediate area of the newly constructed runway facilities. If this runoff is not controlled through the use of a storm drain system, the additional amount of water contributed to the ground water system may result in the creation of localized ground water problem areas. The water collected in the storm drain system should be disposed of away from the immediate vicinity of the runway and taxiway system so that potential problem areas are not mitigated in one area and created in another.

Subsurface return flows of applied landscape irrigation water may also adversely impact ground water conditions close to the runway facilities. Irrigation of runway and taxiway landscaping, if included, should be held to a minimum and efficient irrigation practices observed to minimize effect to the

water table. The potential exists for creating areas where ground water may be mounded near the surface or critically near foundations of the runways and taxiways because of impermeable or less permeable layers of material within the underlying alluvium.

The amount of ground water currently entering the alluvial aquifer underlying the project site may be increased at some time in the future as development of off-site properties takes place. Much of, but not all, the property situated south of the project site is already developed. The surface and ground water impact has been and is being felt on the project site. However, depending upon the nature and extent of the development of lands east and southeast of the site, increased amounts of water from runoff and subsurface irrigation return flows will contribute to the ground water system on the Southern Tier which may result in an elevated water table and the subsequent creation of ground water problem areas in proximity to runway facilities. Even though a ten year life span is anticipated for the new east-west runway facilities, the development of these off-site properties should be monitored closely and their potential effects to the regional alluvial ground water system investigated.

5.0 CONCLUSIONS AND RECOMMENDATIONS OF GROUND WATER INVESTIGATION

5.1 General Conclusions

The shallow ground water investigations conducted on the Southern Tier of the Rocky Mountain Arsenal did not confirm the existence of any ground water problem areas where large scale dewatering to lower the ground water table would be required to construct either of the two east-west runway alternatives planned by Stapleton International Airport. A few potential ground water problem areas in the vicinity of the two conceptualized runway alignments may require a temporary lowering of the water table during and/or following construction. Permanent lowering of the water table is quite remote. The potential for future ground water problem areas were also identified.

5.1.1 General Alluvial Aquifer Conditions

The subsurface soil conditions across the site were found to be very erratic. The alluvial deposits generally consist of a very thin to relatively thick sequence of interbedded layers of silts, clays, sands and gravels with varying hydraulic character. The thickness of the alluvial deposits underlying the project site was found to range from 5 to 97 feet thick across the site. The thinnest deposits occurring in the vicinity of a bedrock high identified in eastern portions of the site, Section 7, Township 3 South, Range 66 West, and the thickest deposits occurring in the vicinity of an extensive buried stream channel system traversing

the western portions of the site in Sections 11 and 12, Township 3 South, Range 67 West.

5.1.2 General Bedrock Conditions

The uppermost bedrock unit underlying the project site was confirmed to be the interbedded shales, siltstones and sandstones of the Denver formation. Although some areas were identified where sandstone layers within the Denver formation were in contact with the alluvium, they were found to be relatively thin, discontinuous and appeared not to be water bearing. As a result, it appears that the Denver formation aquifer is not contributing water to the overlying alluvium within the confines of the project site.

5.1.3 Confined Water Table Condition

Of significant importance were the identification of numerous layers of relatively impermeable material, clays and sandy clays, located throughout the alluvial deposits underlying the site, resulting in localized confined water table conditions. Due to the lenticular and discontinuous nature of these clay and sandy clay layers, however, the water contained in the alluvium is not separated into two distinct aquifer zones. Unconfined water table conditions were found where these relatively impermeable layers of material were absent and in some areas where they were present. The water table contour map, Figure 12, represents the present configuration of the water table which is a

combination of the unconfined water table and the potentiometric head in the areas where confined water table conditions exist.

5.1.4 Perched Water Table Conditions

The presence of the clay and sandy-clay layers results in minor perching of ground water above the water table. Although perched zones were identified only in one area, other zones may exist. Future drilling programs conducted on the runway alignment selected for construction of the new east-west runway facilities should take special precaution in identifying all substantial layers of clay and sandy clay that may provide the potential for perched water zones during construction.

5.1.5 Site Water Table Configuration

The configuration of the water table, as determined by the present investigations, has not changed significantly in the past twenty-eight years. The water table gradient across the site is generally to the northwest towards the South Platte River; however, in the extreme eastern portions of the site a bedrock high bifurcates the incoming flow of ground water entering the site from the southeast and redirects the flow in a more northern direction.

5.1.6 Alluvial Aquifer Recharge

Recharge to the alluvial aquifer underlying the site is primarily from precipitation and the inflow of ground water from the

south and southeast. The aquifer also receives continual and intermittent recharge from on-site and near-site sources including seepage from First Creek, the High Line Lateral, the storm and ground water drainage systems that enter and cross the project site including the Havana Street, Joliet and Uvalda Street Interceptors, Havana Street Lakes and the South Lakes located immediately north of the project site.

The construction of the new east-west runway facilities will result in increased or concentrated amounts of precipitation runoff being contributed to the local ground water system. The results may be either a localized rise in the water table or the creation of areas where water is mounded above the water table on layers of impermeable material. A properly designed storm drain system should be incorporated in the runway and taxiway design to avoid the creation of problem areas.

Due to the apparent lenticular and discontinuous nature of the relatively impermeable layers of materials, only one ground water table exists across the project site. Subsurface return flows from landscape irrigation on the newly constructed runway facilities may result in a localized rise of the water table or be mounded on relatively impermeable layers of material. Both results may create ground water problem areas that may adversely affect the runway facilities.

5.1.7 Aluvial Aquifer Parameters and Flows

Aquifer testing conducted during the investigations indicated the hydraulic conductivity (permeability) of the alluvial aquifer underlying the project site was quite variable, ranging from 0.18 cm/sec (509.04 ft/day) in the western portions of the site to .0068 cm/sec (19.23 ft/day) in the eastern portion of the site. As would be expected, the higher permeability values coincide with the large buried stream channel system and the lower permeabilities where the alluvial deposits are thinnest, in the eastern portions of the project site.

Utilizing average permeability values and average water table gradients, approximately 11 million gallons per day may be entering the project site as ground water. The majority of ground water flow entering the site coincides with the buried stream channel system located in the western portions of the site. This flow value is an approximation and may need to be revised if computer modeling of the regional alluvial ground water system becomes necessary in the future.

5.1.8 Water Table and Runway Construction

Comparison of the elevations of the water table in proximity to the two conceptualized east-west runway alignments with the maximum expected excavation elevations along these alignments indicates that large scale dewatering will not be required. Temporary dewatering during construction of the Northern

Alignment may be required at the western end of the runway and where it will cross over the Rod and Gun Club pond, the Uvalda Interceptor system ditch and the High Line Lateral. The need for temporary dewatering will depend on final design of the runway and taxiway and the structures constructed allowing the Uvalda Interceptor and High Line Lateral to pass beneath them. Temporary or permanent dewatering will be required if a grade separated structure is constructed to pass the existing railroad spur beneath the western end of the Northern Alignment connecting taxiway. The type of dewatering required will depend upon the final design of the structure.

Temporary dewatering may be required at the extreme eastern end of the taxiway paralleling Alignment C and where the runway and taxiway cross the Uvalda Interceptor system ditch. Temporary dewatering may be required if the existing railroad spur located at the western end of Alignment C is not rerouted and a grade separated structure is constructed to allow it to pass beneath the runway. A need for a permanent and full time dewatering system will depend on the design of the railroad spur.

Although large scale dewatering to lower the water table will not be required along either of the two conceptualized runway alignments, Alignment C generally appears to be a more favorable location for the construction of the new east-west runway than the Northern Alignment. Even though a temporary or permanent lowering of the water table may be required if the

railroad spur underpass is constructed at the western end of Alignment C and some temporary dewatering may be required at the eastern end of the taxiway paralleling Alignment C, the water table underlies this alignment at greater depths than along the Northern Alignment. Another advantage of Alignment C is that it will not cross any areas of known contamination.

5.1.9 Off Site Development

The future development of off-site properties located south, east and southeast of the project site which are upgradient from the project site may adversely impact the alluvial ground water system underlying the site at some future date. Adverse impacts may include a general rise in the water table or the creation of ground water problem areas where water is mounded above the water table by layers of relatively impermeable material within the alluvium. The potential adverse effects from increased runoff and/or increased subsurface return flows from landscape irrigation will need to be evaluated at some time in the future if development occurs within the life span of the new east-west runway facilities.

5.2 Recommendations

The recommendations for the project site are intended to address both the existing conditions of the alluvial ground water system beneath the project site and the potential for future ground water problem areas ascertained during the course of our study.

5.2.1 Ground Water Monitoring

It is recommended that the ongoing monitoring of water levels be continued until at least June 1986 with at least quarterly monitoring through the construction period. Determination of the magnitude of seasonal fluctuation of the water table may be critical to the design of the runway facilities. After the magnitude of fluctuation is established, the conceptualized or proposed design of the runway and taxiways should be re-reviewed to ascertain possible adverse effects.

5.2.2 Final Design Drilling Program

When an alignment for the new runway facilities is selected and a final site specific drilling program is conducted, special observation should be made of all substantial layers of clay and sandy clay materials. The presence of these relatively impermeable layers can result in confined and/or perched water table conditions, both of which can adversely impact the runway facilities.

All test holes of the final drilling program should be completed as water level monitoring holes to verify site specific ground water conditions. Anomolies in the water table may exist between the widely spaced test/monitor holes completed during this study. Additional water level monitor holes other than those completed in the final test hole drilling may be required where local conditions warrant their placement.

5.2.3 Dewatering-Runway Alternates

Prior to final design of the new runway facilities, the proposed design plans should be reviewed to determine if the need for general dewatering to lower the water table has changed from those observed for the present Northern Alignment and Alignment C. If said review indicates that large scale dewatering is required, computer modeling of the alluvial ground water system may be necessary to evaluate the effect such dewatering will have on the regional ground water system.

5.2.4 Dewatering-Railroad Spur

Regardless of which runway alignment is selected for construction of the new east-west runway and if the railroad spur is lowered below the ground surface, a site specific study should be done to determine the type of dewatering, permanent or temporary, that will be required. Computer modeling may be necessary to determine the effect to the regional ground water system from this dewatering.

5.2.5 Storm Drain System

A properly designed storm drain system should be incorporated into the runway and taxiway design to control the increased or concentrated amounts of precipitation runoff that will result following construction. The water collected by the storm drain system should not be permanently discharged close to the runway facilities. To avoid the possible creation of ground

water areas, the water collected should be discharged to the existing drainage structures that convey runoff water to the South Lakes, north of the project site.

5.2.6 Landscape Irrigation

Landscape irrigation along the runway facilities should be kept to a minimum. Subsurface return flows from irrigation may cause a localized rise in the elevation of the water table and/or result in mounding water above relatively impermeable layers of material within the alluvium. Both of these potential results could adversely impact the runway operations.

If the landscape along the runway and taxiway alignment is irrigated, efficient irrigation practices should be observed to minimize effects that may increase the height of the water table and create ground water problems.

5.2.7 Off-Site Development

The future development of off-site properties located primarily east and southeast of the project site, which is in an up-gradient direction of the ground water table, should be monitored closely. Depending on the type of development, increased runoff and subsurface return flows from applied landscape irrigation may adversely impact the alluvial ground water system beneath the project site. If the life of the proposed runway is limited, the effect of off-site development may not be a significant factor. If the life of the runway is extended, computer modeling of the

regional ground water system may be required to determine the magnitude of the potential effects.

6.0 GROUND WATER RIGHTS

6.1 Alluvial Wells - Tributary to the South Platte River

Ground water saturates much of the permeable surficial alluvial deposits underlying the Southern Tier of the Rocky Mountain Arsenal. The alluvial deposits consisting of a complex sequence of interbedded silts, clays, sands and gravels, ranges in thickness from five to ninety-seven feet across the project site. The gradient of the alluvial water table across the site is to the northwest towards the South Platte River. The ground water contained in the alluvial deposits is hydraulically connected to the South Platte River's surface water system in the vicinity of the project site. As such, all new large wells (municipal, commercial and irrigation) completed in the alluvium would, therefore, be considered tributary and would be subject to a judically approved plan for augmentation prior to use of the water produced from said well(s). Existing wells in the absence of a plan for augmentation are subject to the priority system under the rules and regulations promulgated by the State Engineer.

6.1.1 Decreed Water Rights

Research of decreed water rights on file with the Colorado Division of Water Resources indicated that there are no decreed water rights associated with the alluvial deposits underlying the project site. Our research, however, did indicate that the U. S.

Department of Justice, Land and Natural Resources, has made Water Court applications to the District Court in and for Water Division 1, State of Colorado, for the adjudication of two existing shallow alluvial wells located on the Southern Tier of the Rocky Mountain Arsenal (Blatchley Associates, Inc. 1985).

In 1977 initial applications were made in Case Nos. W-9164-77 and W-9166-77 for the adjudication of two unpermitted, unregistered wells located on the project site. The well subject to Case No. W-9164-77 is located in the Northeast Quarter of the Northeast Quarter of Section 8, Township 3 South, Range 66 West. The application claims an absolute right to 58.33 cubic feet per second (5,040,000 gallons per day) of water that has historically been used for irrigation of approximately 160 acres of land surrounding the well. (It is the opinion of this consultant that the quantity claimed by W-9164-77 is in error.)

The well subject to Case No. W-9166-77 is located in the Southeast Quarter of the Southeast Quarter of Section 11, Township 3 South, Range 67 West. This application claims an absolute right to 0.040 cubic feet per second or 25,920 gallons per day of water that has historically been used for water supply for picnic grounds.

The location of the two wells subject to the above Water Court Cases in reference to the two new conceptualized east-west runway alignments on the project site are shown on Figures 16 and 17.

On February 28, 1985, an amended application to Case No. W-8439-76, which is included with Case Nos. W-9164-77 and W-9166-77, was filed by the U. S. Government. This amended application is seeking the adjudication of seventeen wells and seven storage reservoirs which have been constructed on the Rocky Mountain Arsenal in years past. All well and reservoir applications subject to Case No. W-8439-76 are awaiting adjudication.

6.1.2 Potential For Future Use

The potential uses of the alluvial ground water under the Southern Tier are unlimited. Any use is subject to the quality of the ground water available from the alluvial aquifer underlying the project site and the judicial approval of a plan of augmentation covering potential depletions to the regional surface water system. The water could conceivably be utilized for a variety of beneficial uses including: domestic, irrigation, commercial, industrial, municipal and recreational.

6.2 Bedrock Well Rights-Nontributary to the South Platte River

6.2.1 Nontributary Aquifers

With the recent passage of Senate Bill 5 (SB-5), Colorado water law pertaining to the classification and appropriation of nontributary ground water within the Denver Basin has been substantially changed. Subsequent to the effective date of SB-5, July 1, 1985, nontributary ground water is now defined as that ground water, the withdrawal of which will not, within one

hundred years, deplete the flow of a natural stream at a rate greater than one-tenth of one percent of the annual rate of withdrawal. Pursuant to the passage of SB-5, the Colorado Division of Water Resources (State Engineer's Office) promulgated rules and regulations to prescribe criteria and procedures for the application, evaluation, issuance and administration of nontributary well permits. As part of the rules and regulations promulgated maps showing the locations and aerial extents of the six principal bedrock aquifers within the Denver Basin were prepared. The area within each aquifer where the ground water is considered "nontributary" and "not nontributary" under Senate Bill 5 criteria are also delineated on these maps.

Four of the six principal bedrock aquifers of the Denver Basin; the Denver, Upper and Lower Arapahoe and the Laramie-Fox Hills aquifers, underlie the Southern Tier of the Rocky Mountain Arsenal. Under SB-5 criteria, only two are defined by the Colorado Division of Water Resources as nontributary: the Lower Arapahoe and Laramie-Fox Hills. Likewise, the Denver and Upper Arapahoe aquifers are defined by the Colorado Division of Water Resources as "not nontributary." As such, judicial approval of plans for augmentation would be required prior to use of the ground water available from those two aquifers.

The Lower Arapahoe aquifer contained in the lower portions of the Arapahoe formation is the uppermost nontributary aquifer underlying the project site. The Lower Arapahoe aquifer ranges

in thickness from about 200 to 250 feet across the site and consists of a series of interbedded light grey to light brown sandstones, siltstones, localized conglomerates and sandy shales. The depth to the top of the Lower Arapahoe ranges from approximately 765 feet below ground level (B.G.L.) in the northwestern portions of the site to about 930 feet B.G.L. in the southeastern portions of the site. The contact between the Arapahoe formation and the successively lower Laramie formation is at depths ranging from about 965 feet to 1180 feet B.G.L. across the site in a northwest to southeast direction.

The upper portion of the Laramie formation is composed predominately of silty gray shales with minor interbeds of fine sandstones and localized coal beds. The depth to the base of the upper Laramie formation ranges from about 1400 to 1500 feet B.G.L. across the site, again in a northwest to southeast direction.

Substantial sandstone lenses contained in the lower portion of the Laramie formation and the sandstone and siltstones of the immediately underlying Fox Hills formation together form the Laramie-Fox Hills aquifer. The aquifer is characterized by an extensive upper sandstone member, overlying a sequence of sandstones, and shales extending to approximate depths ranging between 1600 to 1700 feet.

Beneath the Fox Hills formation lies the Pierre shale formation which consists of approximately 5000 to 8000 feet of relatively uniform gray impermeable shale beds. The upper Pierre

shale contact is usually the lower limit of any water wells drilled in the Denver Basin. Some thin sandstone layer within the Pierre shale yield small quantities of water to wells; however, these quantities are not usually considered an economic water supply in light of the generally poor quality of the water and the drilling depth involved.

6.2.2 Present Permitted Appropriations

Research of the water rights on file with the Colorado Division of Water Resources indicates that there are no presently permitted appropriations of ground water from either of the two nontributary aquifers underlying the Southern Tier of the Rocky Mountain Arsenal.

For a detailed discussion of the ground water rights currently associated with the Rocky Mountain Arsenal in general and the Southern Tier specifically, the reader is referred to a report prepared by Blatchley Associates, Inc. in January 1985.

6.2.3 Potential Nontributary Water Supply Available For Appropriation

Water contained in the nontributary Lower Arapahoe and Laramie-Fox Hills aquifers can only be appropriated by application to the State Engineer. Well permit applications submitted prior to July 7, 1973, were adjudged by the State administrative procedures whereby over 100 years of pumping a well would theoretically dewater a cylinderical sector of the aquifer. The radius of said dewatered cylinder was not confined to the boundaries of an applicant's property. Subsequently, on July 7,

1973, Statue 37-90-137 (Senate Bill 213) was adopted that added a correlative rights doctrine to the management of nontributary aquifers in the State of Colorado. This doctrine allows a ground water appropriator the right to derive annually one percent of the water stored in each nontributary aquifer beneath his property.

The State Engineer's Office has set forth a formula in the rules and regulations accompanying SB-5 which determines the amount of water underlying an applicant's land which can be actually withdrawn. This amount is then divided by 100 to yield the amount of water the applicant is entitled to withdraw annually. The formula utilizes saturated thickness of the sands and/or sandstones comprising the formation and drainage porosity (specific yield) to determine the amount of water available. The water rights of pre and post Senate Bill 213 wells are protected by the rules and regulations established pursuant to the adoption of SB-5. A new application for a nontributary well is adjudged on the basis of the amount of ground water available beneath the applicant's property less any water previously appropriated by pre-Senate Bill 213 well appropriation cylinders that extend onto the property and/or post-Senate Bill 213 well located on the property.

Utilizing these procedures, pre-Senate Bill 213 appropriation cylinders were plotted for permitted wells producing from

the nontributary Lower Arapahoe and Laramie-Fox Hills aquifers within a one-mile radius of the project site. Permitted wells are those that have been granted an appropriation by the State Engineer and whose appropriation cylinders extended onto, or were in close proximity to the project site.

Our research indicates that five pre-Senate Bill 213 wells, meeting the above criteria, were located in the vicinity of the project site. An Arapahoe formation well, permit No. 16178F, registered to Pacific Western Mobil Estates, was found to be located in the Northeast Quarter of the Southeast Quarter of Section 9, Township 3 South, Range 66 West. This well produces water from both the Upper and Lower Arapahoe aquifers; however, neither of the respective appropriation cylinders extend onto the project site.

Two wells, Permit Nos. 16179F and 16180F, located on the Eastwood Estates property in the Western Half of Section 9, Township 3 South, Range 66 West, were also found to be completed in the Arapahoe formation. Each of these two wells also produces water from both the Upper and Lower Arapahoe aquifers. Wells 16179F and 16180F appropriation cylinders from the Lower Arapahoe extend beneath 216 and 6 acres of the project site respectively. Therefore, the total acreage of the project site less this 222 acres is available for appropriation from the nontributary Lower Arapahoe aquifer.

Two Laramie-Fox Hills wells were also identified on the Eastwood Estates property, permit Nos. 16050F and 16051F. The

appropriation cylinders from these wells were found to extend beneath a total of 270 acres of the project site. The total acreage available for appropriation from the Laramie-Fox Hills aquifer would, therefore, be the total project site acreage minus 270 acres.

Combining this analysis with the criteria set forth in SB-5, the amount of nontributary water available for appropriation from the two nontributary aquifers underlying the project site was determined and is presented in Table 1. As shown in Table 2, 397.5 acre-feet per year (af/yr) of nontributary water is available from the Lower Arapahoe aquifer and 642 af/yr from the Laramie-Fox Hills aquifer.

An additional requirement of nontributary appropriations per SB-5, to insure that no water rights are materially affected by withdrawal of nontributary ground water from the Denver Basin aquifers, established a limit on consumption to extinction of nontributary water. No more than 98% of the water withdrawn annually from a well withdrawing nontributary ground water is allowed to be consumed to extinction. An applicant must demonstrate to the reasonable satisfaction of the State Engineer prior to the issuance of the permit(s) that not more than 98% of the water withdrawn will be consumed. Thus, if the total amount of nontributary water available annually from the Lower Arapahoe, 397.5 af/yr, was withdrawn only 389.55 af/yr could be consumed to extinction. Likewise, only 629.16 af/yr of the 642 af/yr available from the Laramie-Fox Hills aquifer could be consumed.

6.2.4 Not Nontributary Aquifers

As discussed in Section 6.2, subsection 6.2.1 of this report, under current Colorado water law there are two aquifers underlying the project site which are classified not nontributary: the Denver and Upper Arapahoe aquifers.

The Denver formation containing the Denver aquifer is the uppermost bedrock unit underlying the project site. The Denver formation, which is covered by five to ninety-seven feet of alluvial deposits across the project site extends to depths ranging from about 415 to about 560 feet B.G.L. and is composed predominately of light gray to dark brown silty claystones and shales interbedded with lenses of sandstone and siltstone. Localized beds of coal are also found in the upper portions of the formation.

The Upper Arapahoe aquifer contained within the upper portions of the Arapahoe formation immediately underlies the Denver formation throughout the project site. The depth to the top of the Upper Arapahoe aquifer ranges from approximately 440 to 605 feet B.G.L. across the site and extends to depths ranging from about 680 to 830 feet B.G.L. The upper portions of the Arapahoe formation is comprised of the same type of material as that found in the lower portions, interbedded sandstones, siltstones, localized conglomerates and sandy shales.

6.2.5 Present Permitted Appropriations

As in the case of the nontributary aquifers underlying the project site, our research indicated there are no presently permitted appropriations of ground water from the two not nontributary aquifers underlying the Southern Tier of the Rocky Mountain Arsenal.

6.2.6 Potential Not Nontributary Water Supply Available For Appropriation

Water contained in the not nontributary Denver and Upper Arapahoe aquifers is also available for appropriation by application to the State Engineer. Senate Bill 5 specifies in revised Statute 37-90-137(8)(c) that wells completed in the Denver Basin aquifers that withdraw ground water which is not nontributary are subject to a judicially appproved plan of augmentation prior to the use of the water. All wells completed within one mile of the point of contact between the saturated alluvium of any natural stream and the aquifer that the well is completed in are required to replace the actual calculated depletions to the affected stream system(s). All wells completed more than one mile from the aquifer/stream contact are required to replace 4 percent of the amount of water withdrawn on an annual basis.

Employing the same procedures utilized to calculate the amount of nontributary ground water available for appropriation, the amount of not nontributary ground water available for appropriation from the Denver and Upper Arapahoe aquifers was

determined and is also presented in Table 2. As indicated in Table 2, a total of 544 af/yr is available from the Denver Aquifer and 397.5 af/yr from the Upper Arapahoe aquifer. Research of State records indicated that there were no prior appropriations by pre-Senate Bill 213 wells affecting the Denver aquifer beneath the site. The total acreage of the project site is, therefore, available for appropriation subject to an approved plan for augmentation.

The Denver aquifer is in contact with First Creek which traverses the Northeast Quarter of the site in Section 8, Township 3 South, Range 66 West. Each Denver well completed within one mile of the saturated alluvium associated with First Creek will be required to replace its actual calculated amount of depletion to the stream system. All of Section 8 and approximately 214 acres of the eastern portion of Section 7, Township 3 South, Range 66 West, are within this one mile limit. All Denver aquifer wells located beyond this one mile limit will be required to replace 4 percent of their annual appropriations.

Research of pre-Senate Bill 213 wells producing from the Upper Arapahoe aquifer within a one-mile radius of the project site revealed that both of the Eastwood Estates Arapahoe wells, permit Nos. 16179F and 16180F, and the Pacific Western Arapahoe well, permit No. 16178F, produce water from both the Upper and Lower Arapahoe aquifers. The theoretical radius of effect from both of the Eastwood Estates wells extend onto the project site.

The result is a reduction of the total acreage of the project site available for appropriation by approximately 222 acres. This equates to a reduction in the total amount of water available from 435.2 af/yr to 397.5 af/yr.

The Upper Arapahoe aquifer beneath the entire site is located more than one mile from its contact with a natural stream. Therefore, 4 percent of the water produced annually from each well will be required to be replaced to the South Platte River system under an approved plan for augmentation.

7.0 REFERENCES

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Table 1

ALLUVIAL AQUIFER
HYDRAULIC CONDUCTIVITY
TEST RESULTS

Stapleton International Airport
Southern Tier Of Rocky Mountain Arsenal

Test/Monitor Hole No.	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)
11-1	6.1×10^{-2}	172.51
11-4A	18.0×10^{-2}	509.04
12-2	3.7×10^{-2}	104.64
12-4	3.1×10^{-3}	8.77
8-3	6.8×10^{-3}	19.23

Table 2

NONTRIBUTARY AND NOT NONTRIBUTARY
WATER AVAILABLE

Southern Tier of Rocky Mountain Arsenal

Aquifer	Acreage Available for Approp.	Specific Yield	Saturated Thickness (ft) (5)	Total Water Available (Af/Yr) (6)
NONTRIBUTARY				
Lower Arapahoe (1)	2338	17%	100	397.5
Laramie-Fox Hills (2)	2290	15%	187	642.0
			Total	1039.5 (7)
NOT NONTRIBUTARY				
Denver (3)	2560	17%	125	544.0
Upper Arapahoe (4)	2443	17%	200	397.5
			Total	941.5 (8)

Notes:

(1) Prior appropriations in the Lower Arapahoe aquifer by Eastwood Estates wells, Permit Nos. 16179F and 16180F, extend beneath approximately 216 and 6 acres of the project site, respectively. Total prior appropriation equals 222 acres.

(2) Prior appropriations by Eastwood Estates Laramie-Fox Hills Wells, permit Nos. 16050F and 16051F, extend beneath a total of 270 acres of the project site, 257 acres and 13 acres respectively.

(3) Entire 2560 acres of project site available for appropriation.

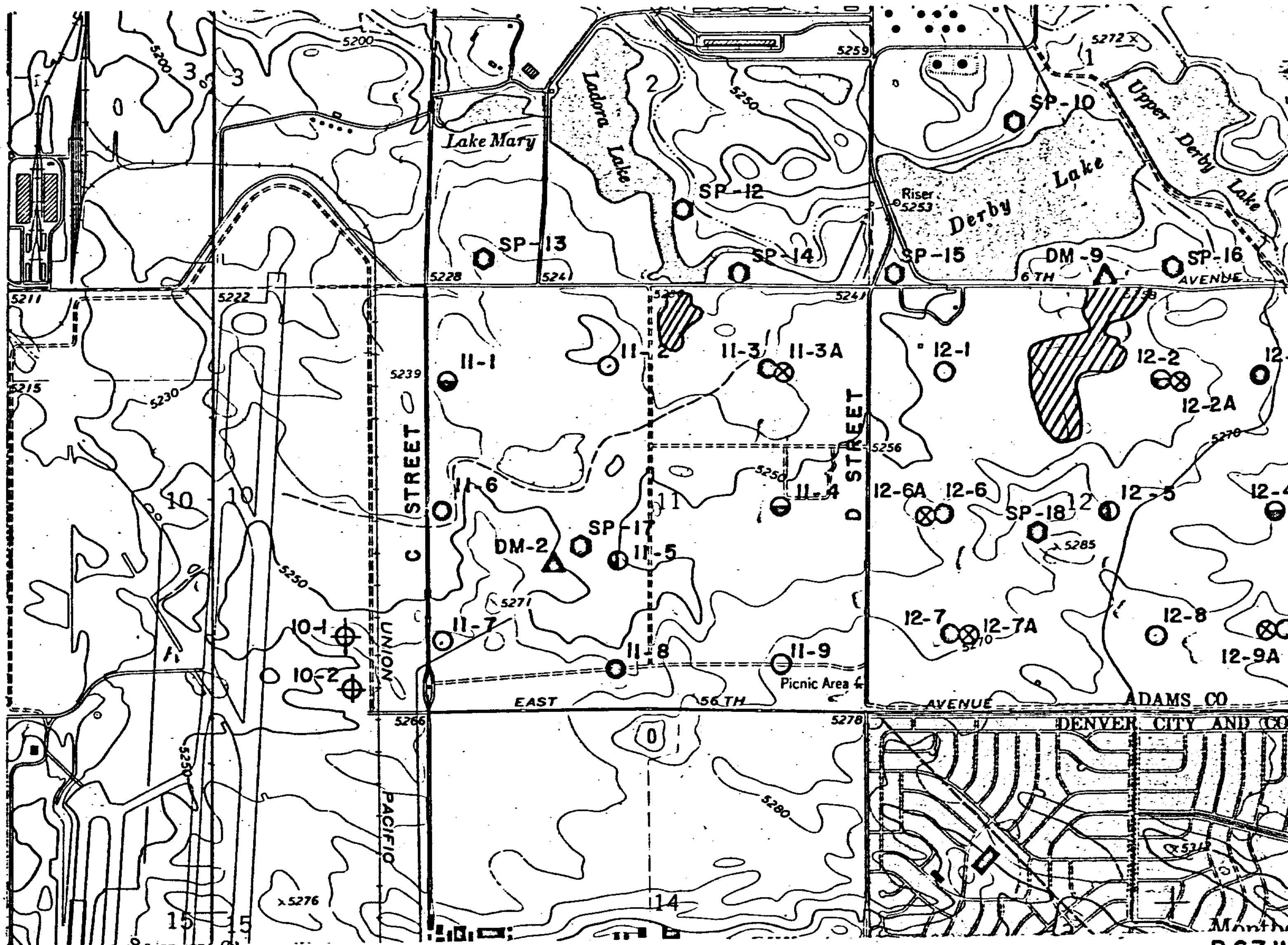
(4) Prior appropriations in the Upper Arapahoe aquifer by Eastwood Estates wells, Permit Nos. 16179F and 16180F, extend beneath approximately 216 and 6 acres of the project site, respectively. Total prior appropriation equals 222 acres.

(5) Average saturated thickness as determined from maps produced by the Colorado Division of Water Resources to accompany Senate Bill 5 Rules and Regulations for the Denver Basin (1985).

(6) Total Water Available = Acreage X Specific Yield X Saturated Thickness - 100 year life.

(7) Only 98% of the total annual amount of nontributary produced from any well can be consumed.

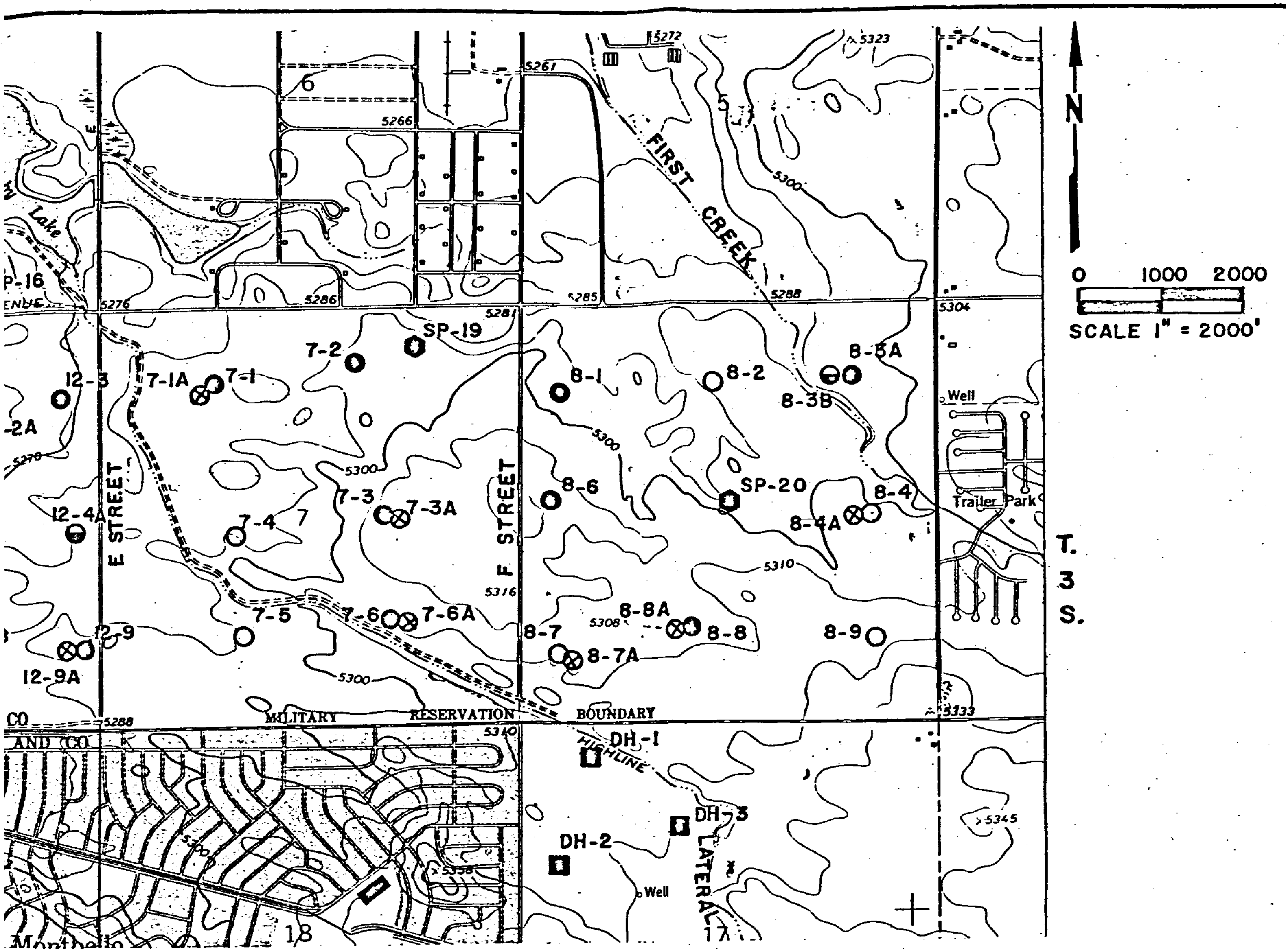
(8) Depending upon the locations of wells producing not nontributary water either actual calculated stream depletions attributed to each well or 4% of the annual amounts produced from each well will be required to be replaced to the affected stream system(s) under a court approved plan of augmentation prior to use of said water(s).



LEGEND

- 11-2 Phase 1 test/monitor hole with identifying number.
- 11-3 Phase 2 test/monitor hole with identifying number.
- 11-1 Phase 3 test/monitor hole with identifying number.
- 11-3A Phase 4 test/monitor hole with identifying number.
- 11-5 Phase 5 test/monitor hole with identifying number.
- 10-1 Phase 6 test/monitor hole with identifying number.
- SP-17 Pre-Existing monitor hole with identifying number
- DM-9 Pre-Existing monitor hole with identifying number.
- DH-1 Pre-Existing monitor hole with identifying number
- Area of known contamination

FIGURE 2

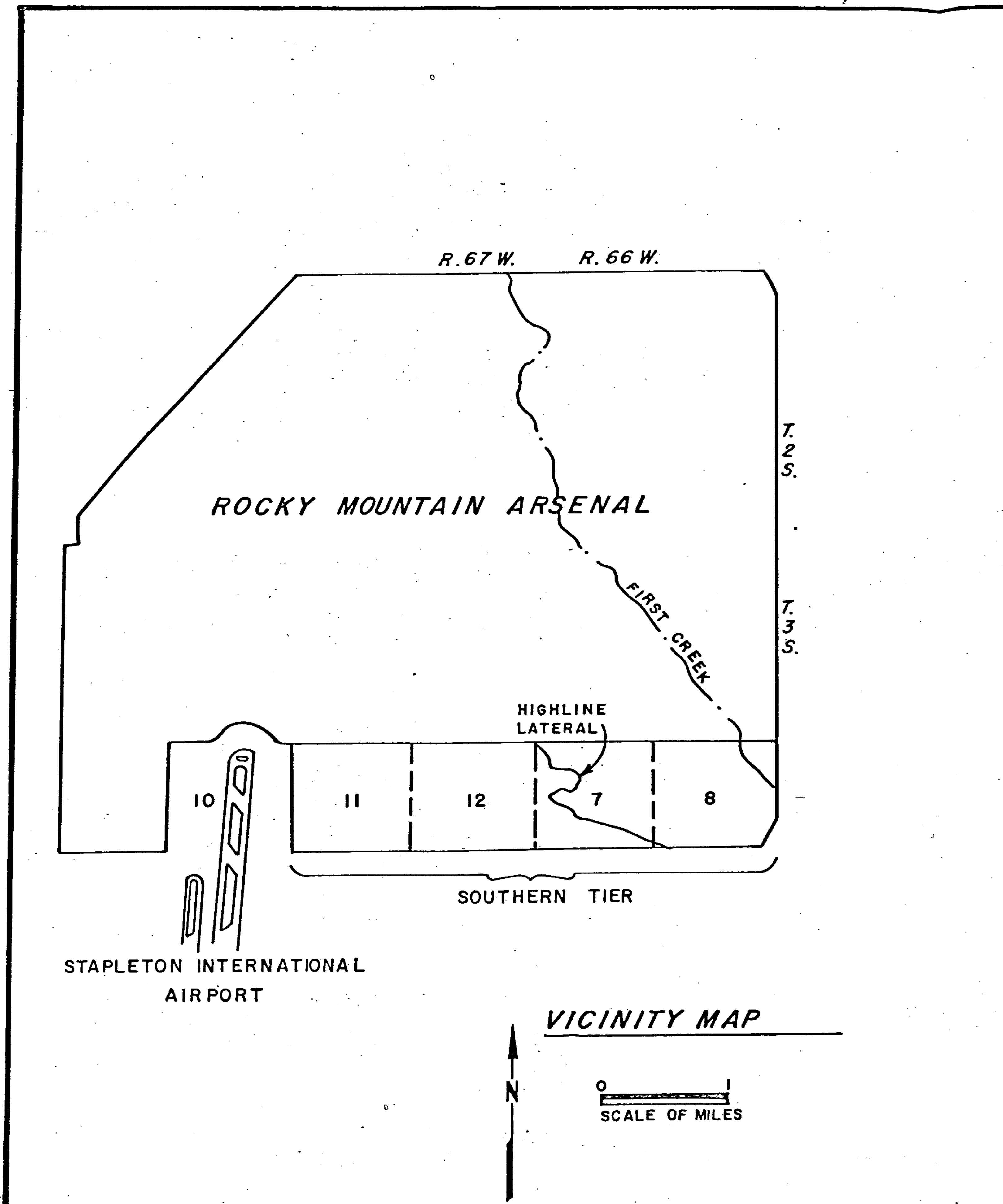


R.67 W. R.66 W.

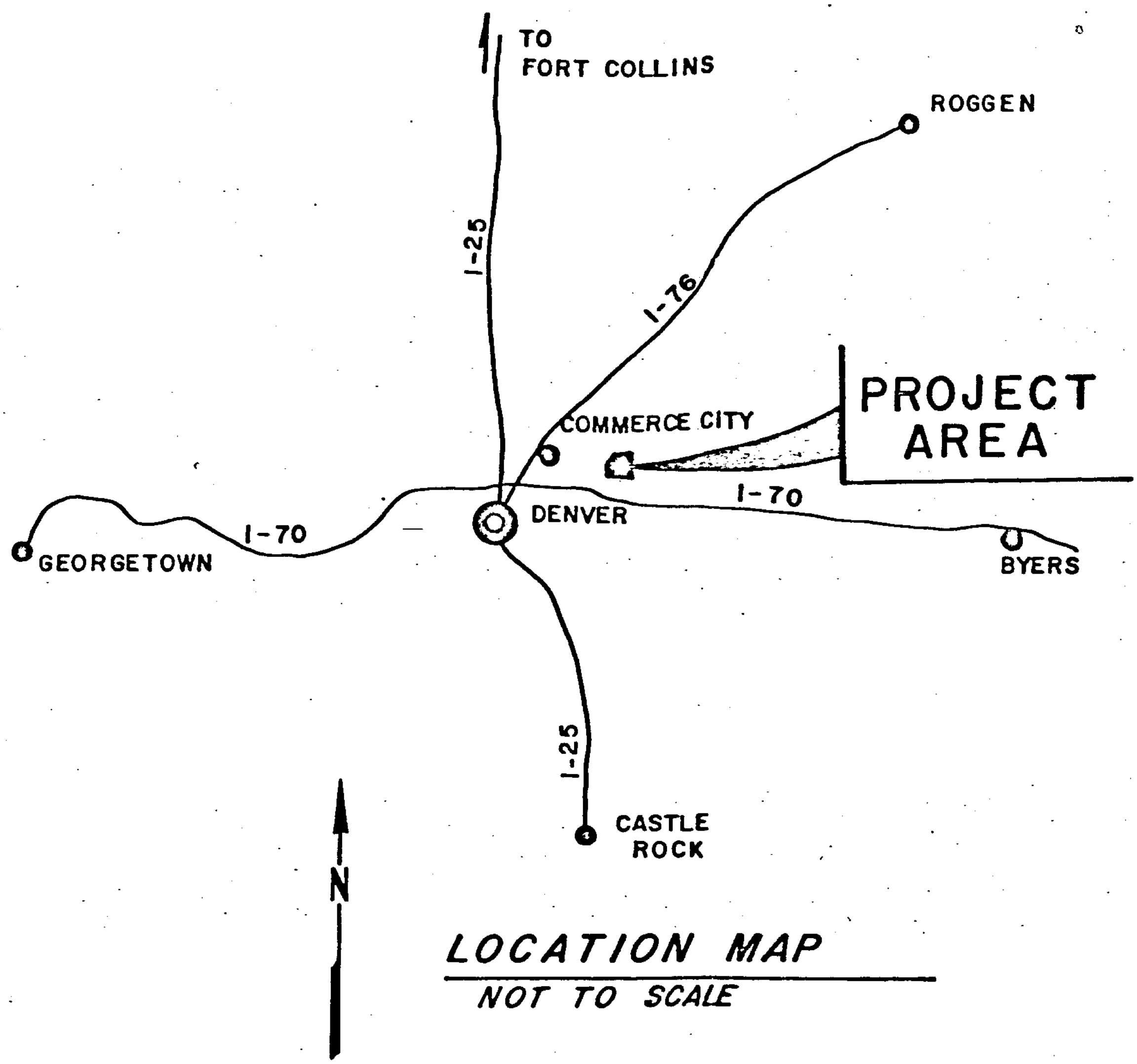
TEST/MONITOR HOLES LOCATION MAP

STAPLETON INTERNATIONAL AIRPORT SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, Inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD, #306
DENVER, COLORADO 80227



VICINITY MAP



LOCATION MAP

NOT TO SCALE

PROJECT

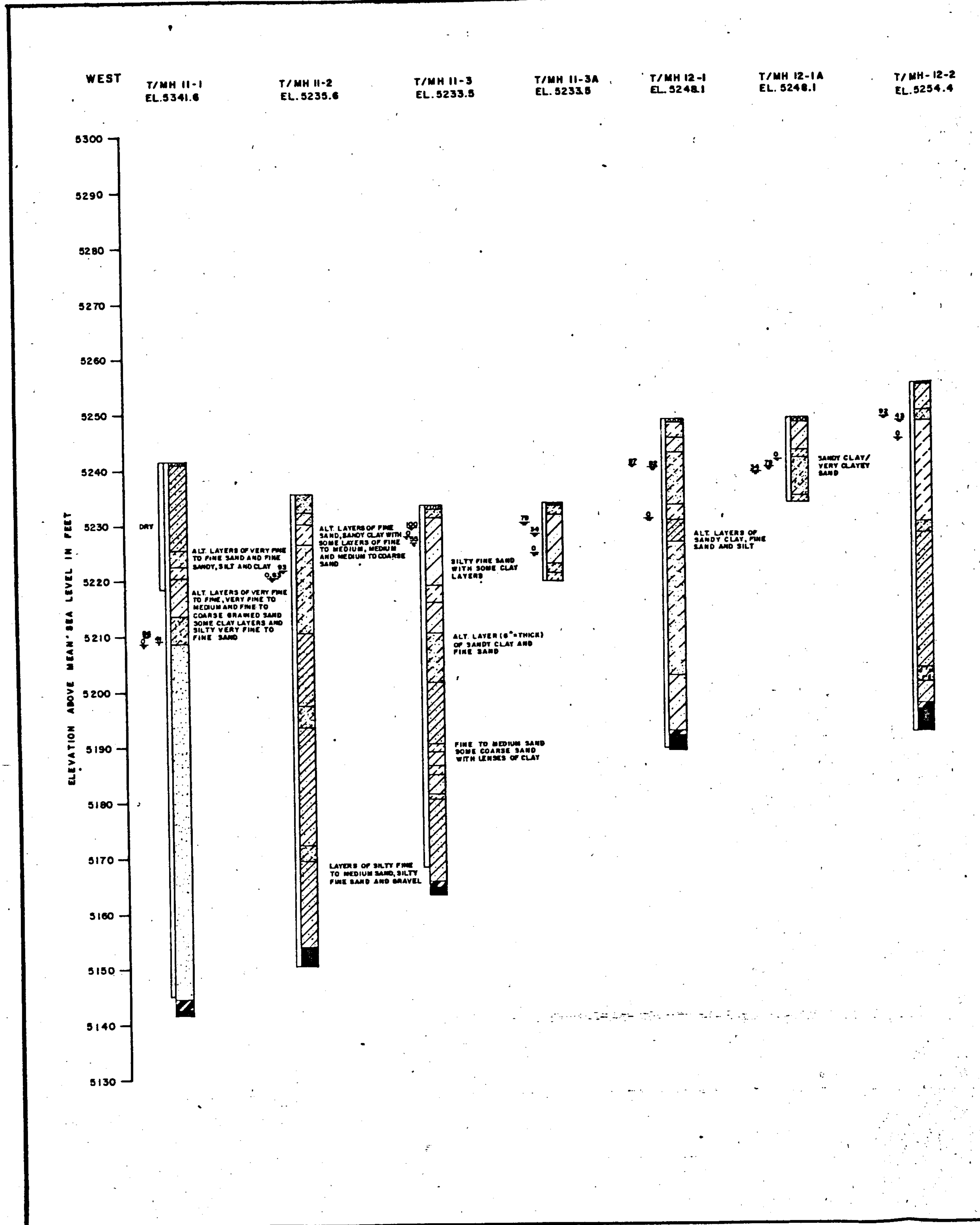
VICINITY AND LOCATION MAP

STAPLETON INTERNATIONAL AIRPORT

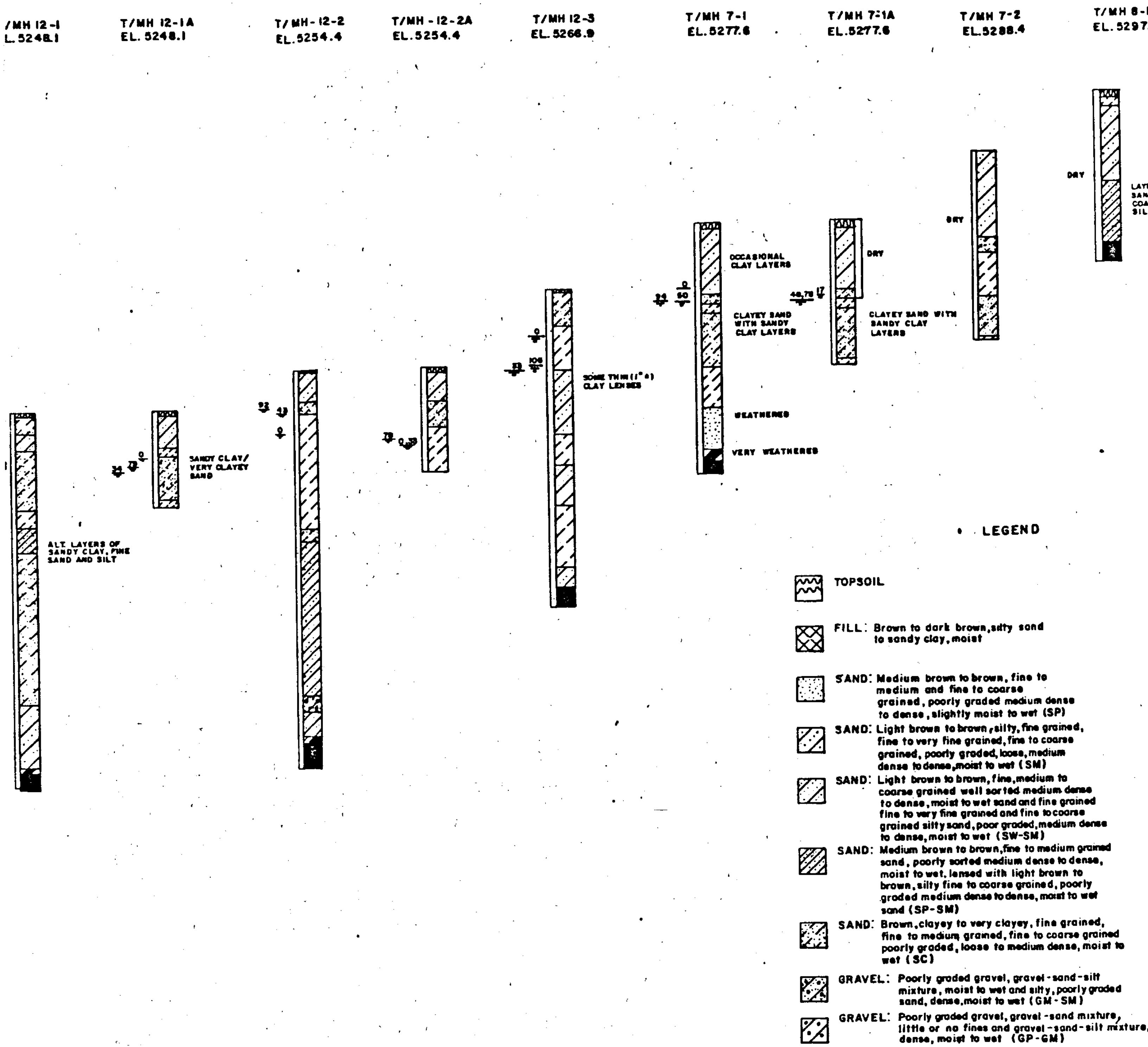
EXPANSION PROJECT

SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, Inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD, #306
DENVER, COLORADO 80227

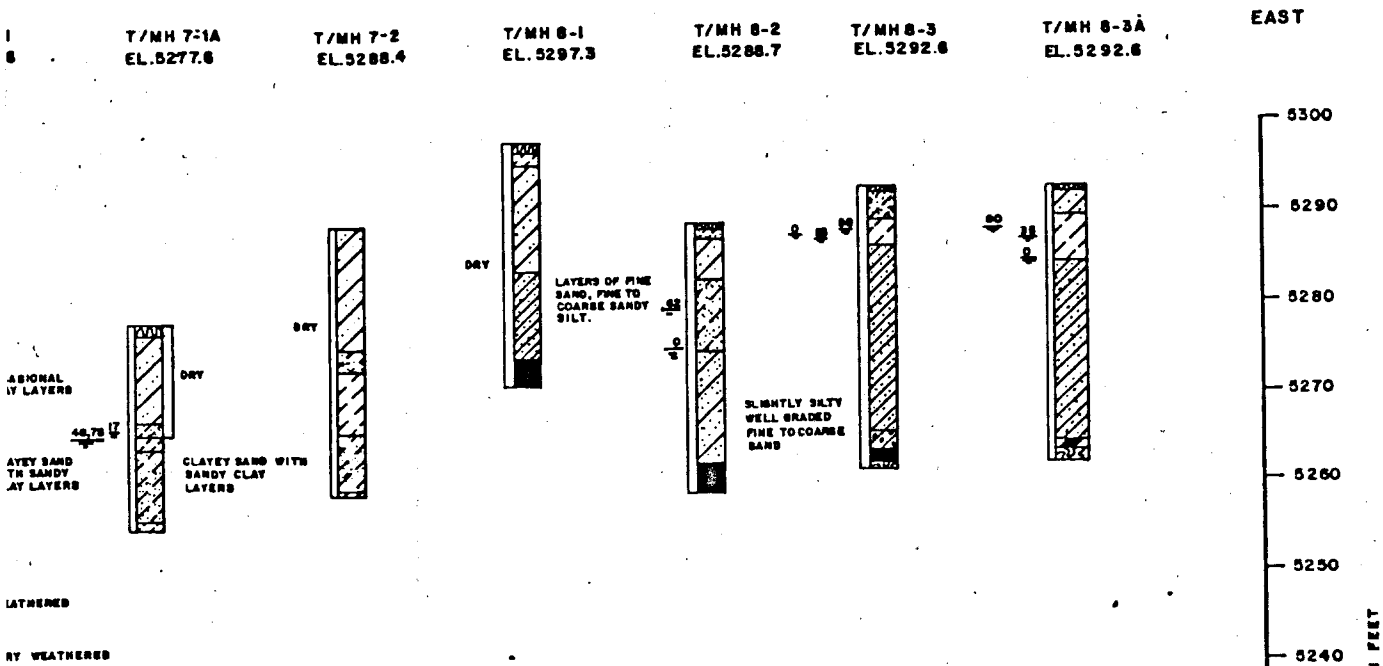


WEST
T/MH 11-1
EL. 5341.6
T/MH 11-2
EL. 5235.6
T/MH 11-3
EL. 5233.5
T/MH 11-3A
EL. 5233.5
T/MH 12-1
EL. 5248.1
T/MH 12-1A
EL. 5248.1
T/MH-12-2
EL. 5254.4
ELEVATION ABOVE MEAN SEA LEVEL IN FEET
5300
5290
5280
5270
5260
5250
5240
5230
5220
5210
5200
5190
5180
5170
5160
5150
5140
5130
DRY
ALT. LAYERS OF VERY FINE TO FINE SAND AND FINE SANDY, SILT AND CLAY
ALT. LAYERS OF VERY FINE TO FINE, VERY FINE TO MEDIUM AND FINE TO COARSE GRAINED SAND SOME CLAY LAYERS AND SILTY VERY FINE TO FINE SAND
ALT. LAYERS OF FINE SAND, SANDY CLAY WITH SOME LAYERS OF FINE TO MEDIUM, MEDIUM AND MEDIUM TO COARSE SAND
LAYERS OF SILTY FINE TO MEDIUM SAND, SILTY FINE SAND AND GRAVEL
SILTY FINE SAND WITH SOME CLAY LAYERS
ALT. LAYER (6"±THICK) OF SANDY CLAY AND FINE SAND
FINE TO MEDIUM SAND SOME COARSE SAND WITH LENSES OF CLAY
ALT. LAYERS OF SANDY CLAY, FINE SAND AND SILT
SANDY CLAY/ VERY CLAYEY SAND



NOTES:

1. NOTES ON LOGS DEFINE SOIL AND B CLASSIFICATIONS WHICH STANDARD DO NOT ADEQUATELY CLASSIFY.
2. HORIZONTAL SCALE NOT APPROPRIA



LEGEND

TOPSOIL

FILL: Brown to dark brown, silty sand to sandy clay, moist

SAND: Medium brown to brown, fine to medium and fine to coarse grained, poorly graded medium dense to dense, slightly moist to wet (SP)

SAND: Light brown to brown, silty, fine grained, fine to very fine grained, fine to coarse grained, poorly graded, loose, medium dense to dense, moist to wet (SM)

SAND: Light brown to brown, fine, medium to coarse grained well sorted medium dense to dense, moist to wet sand and fine grained fine to very fine grained and fine to coarse grained silty sand, poor graded, medium dense to dense, moist to wet (SW-SM)

SAND: Medium brown to brown, fine to medium grained sand, poorly sorted medium dense to dense, moist to wet, lensed with light brown to brown, silty fine to coarse grained, poorly graded medium dense to dense, moist to wet sand (SP-SM)

SAND: Brown, clayey to very clayey, fine grained, fine to medium grained, fine to coarse grained poorly graded, loose to medium dense, moist to wet (SC)

GRAVEL: Poorly graded gravel, gravel-sand-silt mixture, moist to wet and silty, poorly graded sand, dense, moist to wet (GM-SM)

GRAVEL: Poorly graded gravel, gravel-sand mixture, little or no fines and gravel-sand-silt mixture, dense, moist to wet (GP-GM)

CLAY: Medium brown, brown to grey brown low to medium plasticity, slightly sandy to sandy, slightly stiff to very stiff, moist to very moist to wet. (CL)

CLAY: Brown, highly plastic, firm to very firm, wet (CH)

SANDSTONE: Brown, fine to medium grained, slightly to very clayey, silty, very hard, slightly moist to moist (BEDROCK)

WEATHERED CLAYSTONE: Brown, blue, grey, olive, slightly sandy, to very sandy, occasionally calcareous, occasional gypsum, low to highly plastic, moist (WEATHERED BEDROCK)

CLAYSTONE: Brown, blue, grey, olive, slightly sandy to very sandy, occasionally calcareous, occasionally iron stained, occasional gypsum, low to highly plastic, firm, medium hard to very hard, moist (BEDROCK)

COAL: Black, very hard, moist.

PVC OR FIBERGLASS PIPE
MATERIAL CLASSIFICATIONS

Depth to water, number indicating number of days after drilling measurements are made.

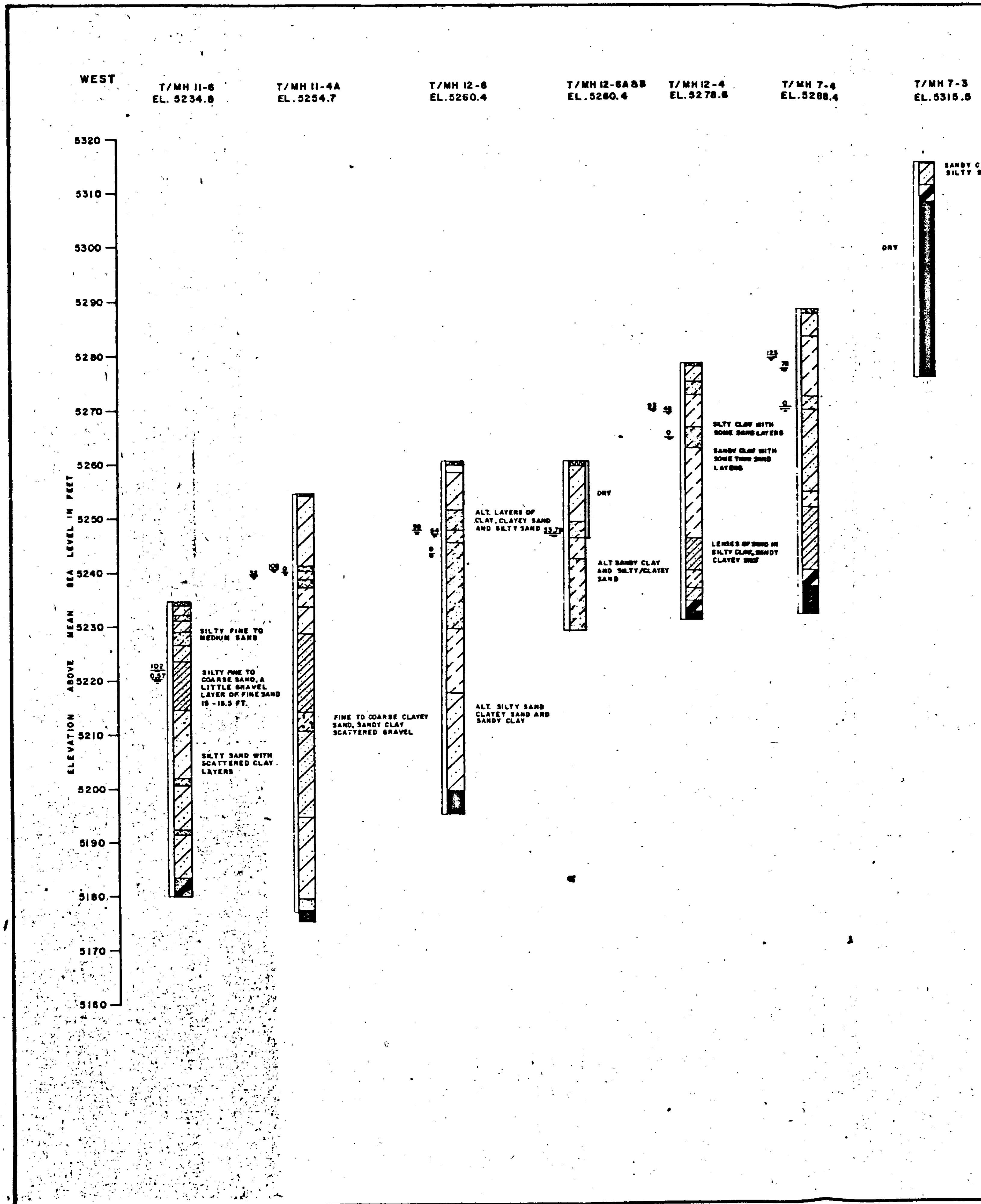
NOTES:

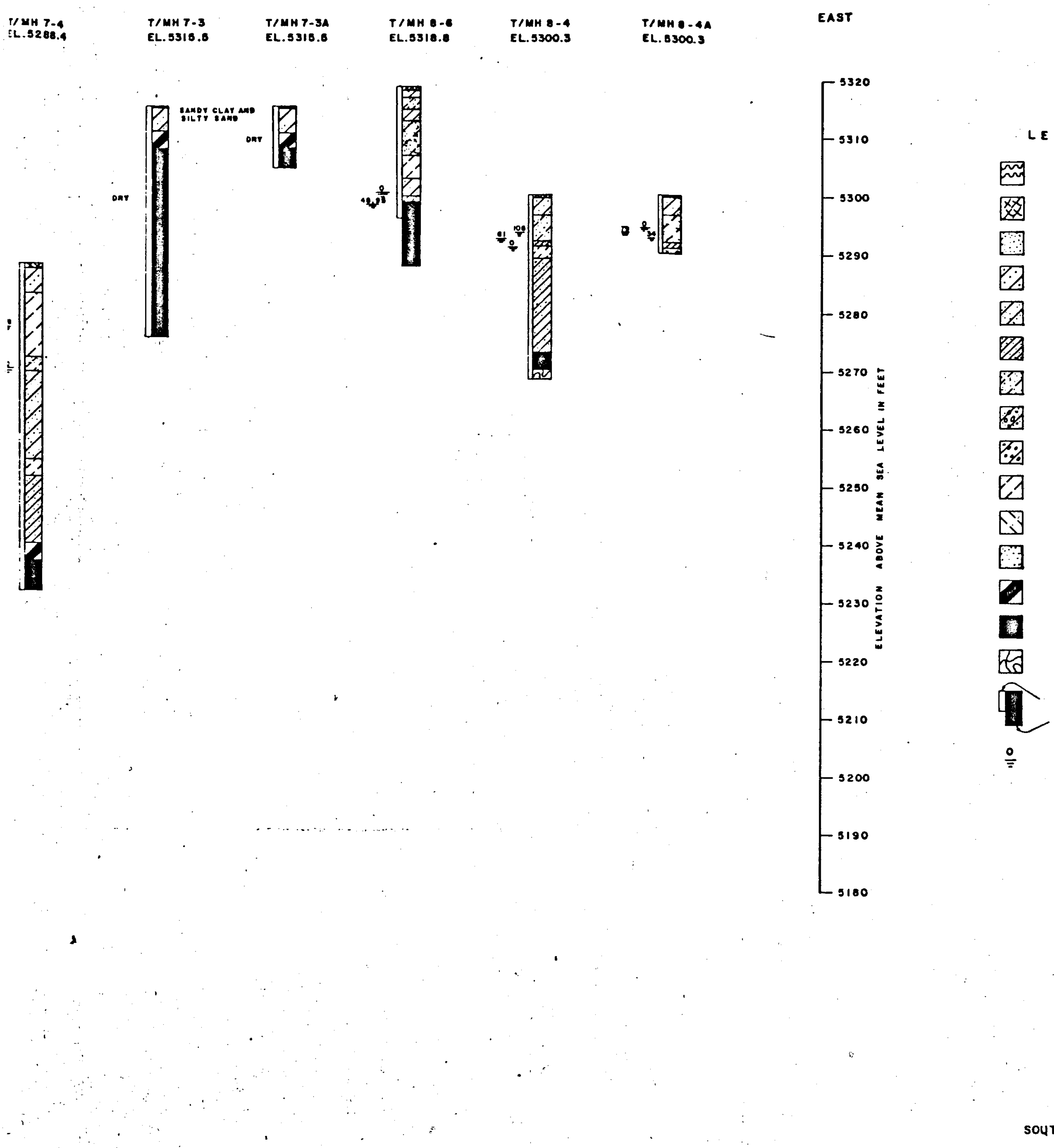
1. NOTES ON LOGS DEFINE SOIL AND BEDROCK CLASSIFICATIONS WHICH STANDARD SYMBOLS DO NOT ADEQUATELY CLASSIFY.
2. HORIZONTAL SCALE NOT APPROPRIATE.

LOGS OF TEST/MONITOR HOLES
NORTHERN TEST/MONITOR HOLES

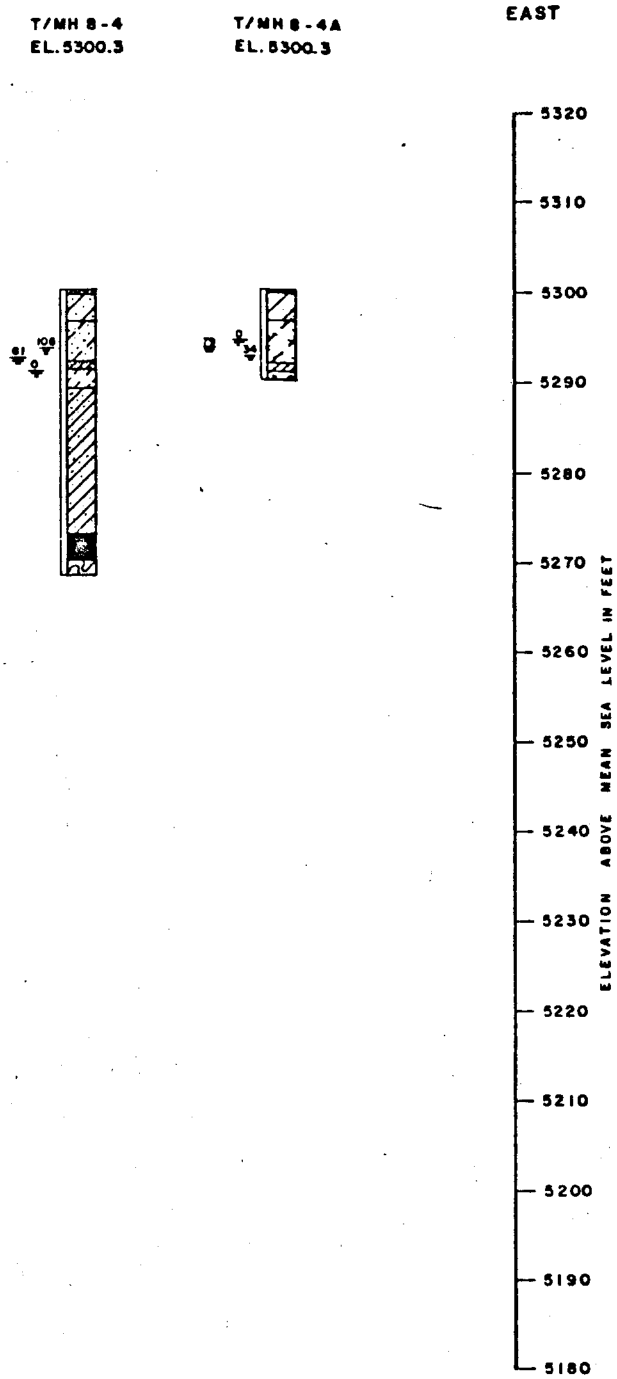
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF THE ROCKY MOUNTAIN ARSENAL

blatchley associates, inc.
CONSULTING ENGINEERS


WEST
T/MH 11-6
EL. 5234.8
T/MH 11-4A
EL. 5254.7
T/MH 12-6
EL. 5260.4
T/MH 12-6A&B
EL. 5260.4
T/MH 12-4
EL. 5278.6
T/MH 7-4
EL. 5288.4
T/MH 7-3
EL. 5316.5
ELEVATION ABOVE MEAN SEA LEVEL IN FEET
5320
5310
5300
5290
5280
5270
5260
5250
5240
5230
5220
5210
5200
5190
5180
5170
5160
SILTY FINE TO MEDIUM SAND
SILTY FINE TO COARSE SAND, A LITTLE GRAVEL LAYER OF FINE SAND 15 - 18.5 FT.
SILTY SAND WITH SCATTERED CLAY LAYERS
FINE TO COARSE CLAYEY SAND, SANDY CLAY SCATTERED GRAVEL
ALT. LAYERS OF CLAY, CLAYEY SAND AND SILTY SAND
ALT. SILTY SAND CLAYEY SAND AND SANDY CLAY
DRY
ALT SANDY CLAY AND SILTY/CLAYEY SAND
SILTY CLAY WITH SOME SAND LAYERS
SANDY CLAY WITH SOME THIN SAND LAYERS
DRY



T/MH 7-4
EL.5288.4
T/MH 7-3
EL.5316.5
T/MH 7-3A
EL.5316.5
T/MH 8-6
EL.5318.8
T/MH 8-4
EL.5300.3
T/MH 8-4A
EL.5300.3
EAST
SANDY CLAY AND SILTY SAND
DRY
DRY
5320
5310
5300
5290
5280
5270
5260
5250
5240
5230
5220
5210
5200
5190
5180
ELEVATION ABOVE MEAN SEA LEVEL IN FEET
LE
SOUT



LEGEND

- TOPSOIL
- FILL
- SAND (SP)
- SAND (SM)
- SAND (SW-SM)
- SAND (SP-SM)
- SAND (SC)
- GRAVEL (GM-SM)
- GRAVEL (GP-GM)
- CLAY (CL)
- CLAY (CH)
- SANDSTONE BEDROCK
- WEATHERED CLAYSTONE BEDROCK
- CLAYSTONE BEDROCK
- COAL
- PVC OR FIBERGLASS PIPE
  MATERIAL CLASSIFICATIONS
- DEPTH TO WATER, NUMER INDICATING NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE

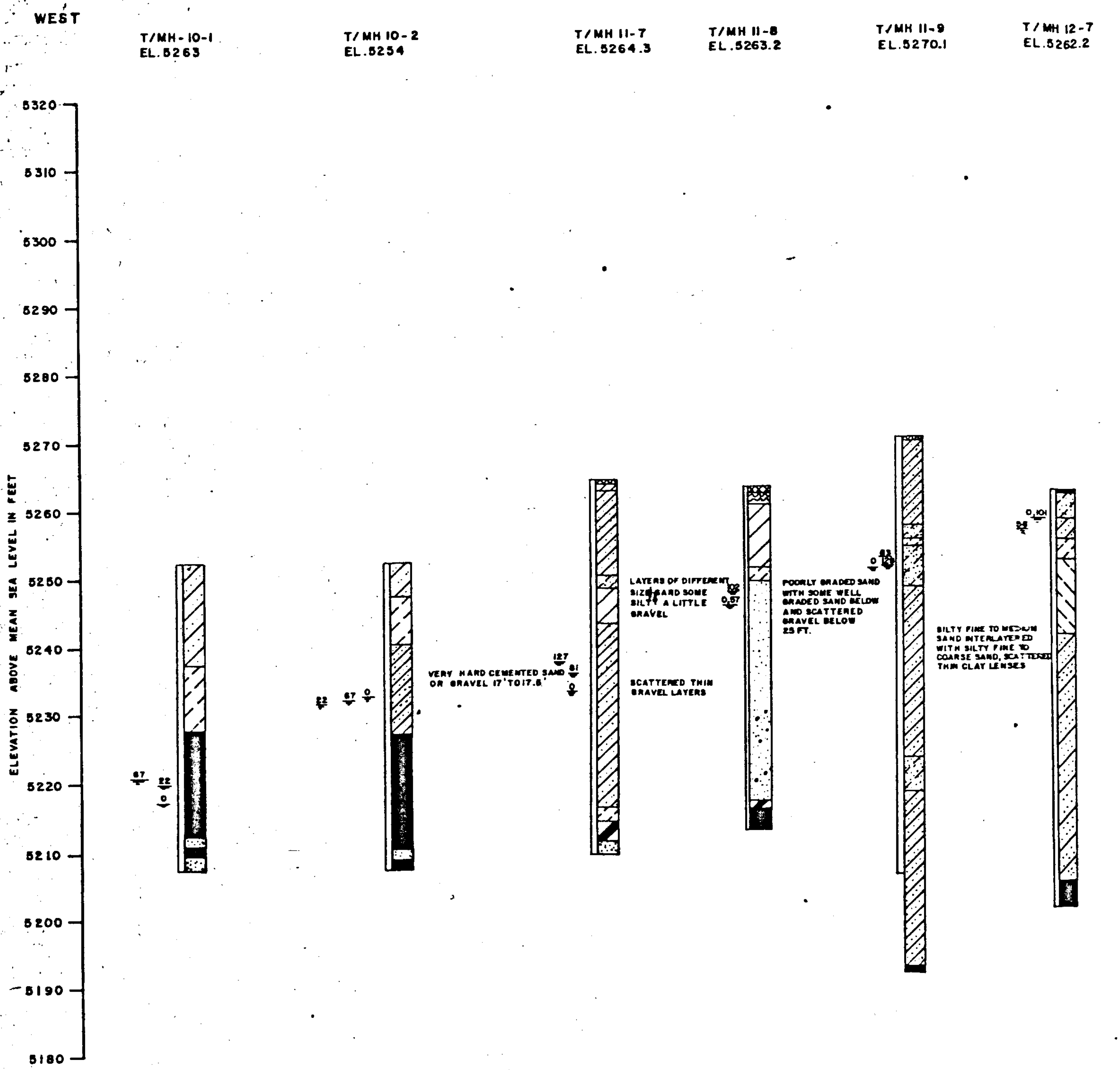
NOTES:

1. SEE FIGURE 6 FOR FULL DEFINITION OF MATERIAL CLASSIFICATIONS.
2. NOTES ON LOGS DEFINE SOIL AND BEDROCK CLASSIFICATIONS WHICH STANDARD SYMBOLS DO NOT ADEQUATELY CLASSIFY.
3. HORIZONTAL SCALE NOT APPROPRIATE.

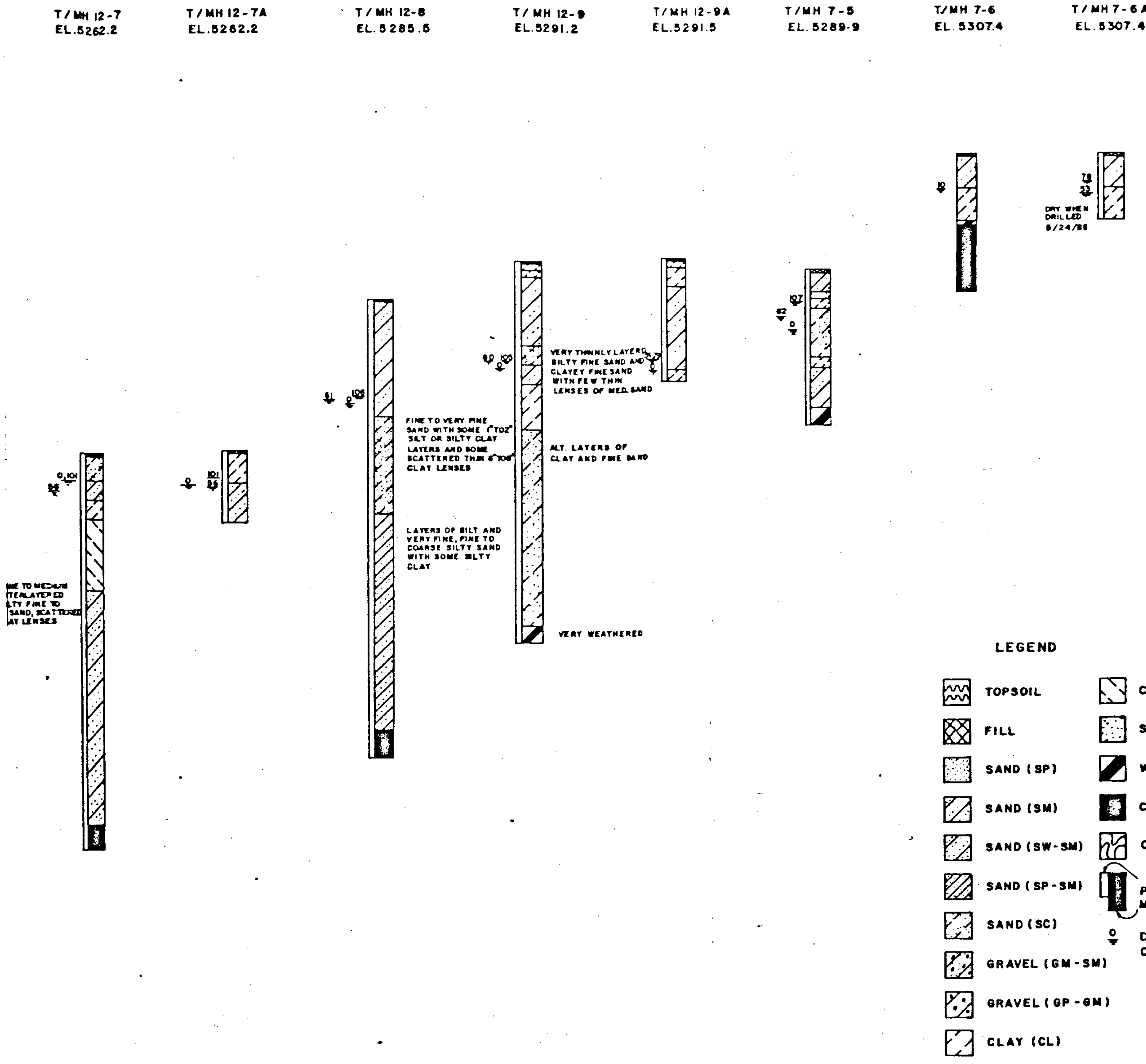
LOGS OF TEST/ MONITOR HOLES
CENTRAL TEST/ MONITOR HOLES

STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF THE ROCKY MOUNTAIN ARSENAL

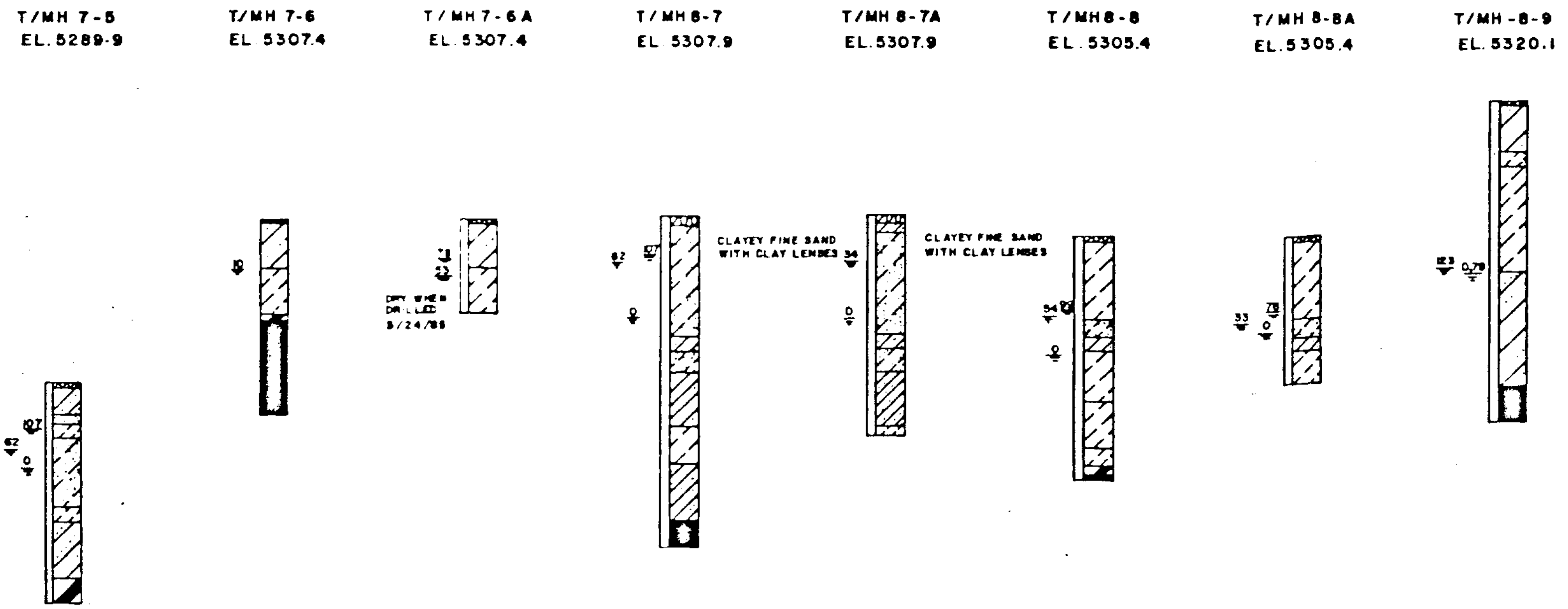
blatchley avodotev, inc.
CONSULTING ENGINEERS



WEST
T/MH-10-1
EL.5263
T/MH 10-2
EL.5254
T/MH 11-7
EL.5264.3
T/MH 11-8
EL.5263.2
T/MH 11-9
EL.5270.1
T/MH 12-7
EL.5262.2
ELEVATION ABOVE MEAN SEA LEVEL IN FEET
5320
5310
5300
5290
5280
5270
5260
5250
5240
5230
5220
5210
5200
5190
5180
VERY HARD CEMENTED SAND OR GRAVEL 17'TO17.5'
LAYERS OF DIFFERENT SIZE SAND SOME SILTY A LITTLE GRAVEL
SCATTERED THIN GRAVEL LAYERS
POORLY GRADED SAND WITH SOME WELL GRADED SAND BELOW AND SCATTERED GRAVEL BELOW 25 FT.
SILTY FINE TO MEDIUM SAND INTERLAYERED WITH SILTY FINE TO COARSE SAND, SCATTERED THIN CLAY LENSES



T/MH 12-7
EL.5262.2
T/MH 12-7A
EL.5262.2
T/MH 12-8
EL.5285.5
T/MH 12-9
EL.5291.2
T/MH 12-9A
EL.5291.5
T/MH 7-5
EL.5289.9
T/MH 7-6
EL.5307.4
EL.5307.4
DRY WHEN DRILLED 8/24/88
VERY THINLY LAYERED SILTY FINE SAND AND CLAYEY FINE SAND WITH FEW THIN LENSES OF MED. SAND
FINE TO VERY FINE SAND WITH SOME 1"TO2" SILT OR SILTY CLAY LAYERS AND SOME SCATTERED THIN 6"TO8" CLAY LENSES
ALT. LAYERS OF CLAY AND FINE SAND
LAYERS OF SILT AND VERY FINE, FINE TO COARSE SILTY SAND WITH SOME SILTY CLAY
VERY WEATHERED
LEGEND
TOPSOIL
FILL
SAND (SP)
SAND (SM)
SAND (SW-SM)
SAND (SP-SM)
SAND (SC)
GRAVEL (GM-SM)
GRAVEL (GP-GM)
CLAY (CL)



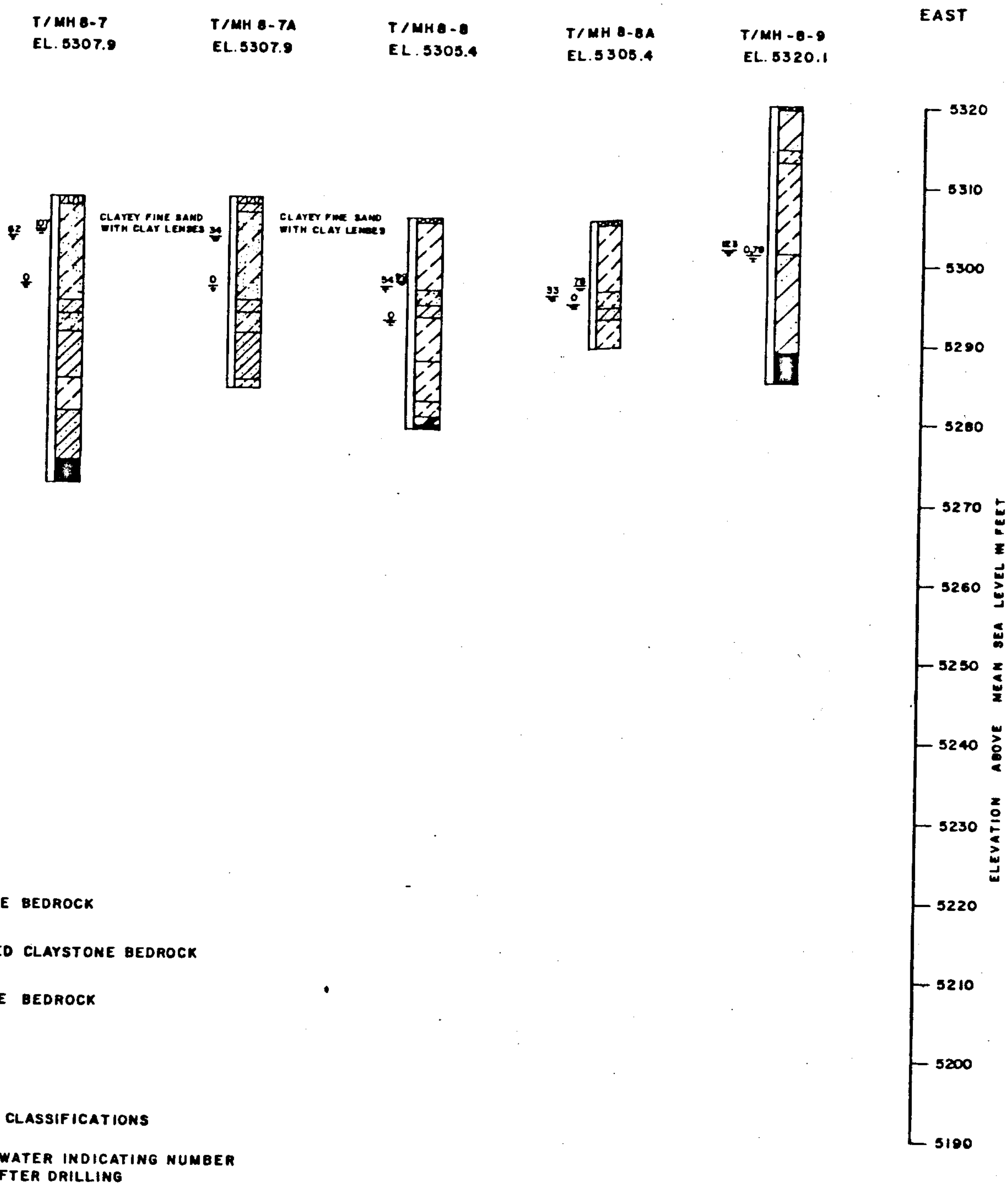
LEGEND

- TOPSOIL
- FILL
- SAND (SP)
- SAND (SM)
- SAND (SW-SM)
- SAND (SP-SM)
- SAND (SC)
- GRAVEL (GM-SM)
- GRAVEL (GP-GM)
- CLAY (CL)
- CLAY (CH)
- SANDSTONE BEDROCK
- WEATHERED CLAYSTONE BEDROCK
- CLAYSTONE BEDROCK
- COAL
- PVC
- MATERIAL CLASSIFICATIONS
- DEPTH OF WATER INDICATING NUMBER OF DAYS AFTER DRILLING

NOTES:

1. SEE FIGURE 6 FOR FULL DEFINITIONS OF SOIL AND BEDROCK CLASSIFICATIONS.
2. NOTES ON LOGS DEFINE SOIL AND BEDROCK CLASSIFICATIONS WHICH STANDARD SYMBOLS DO NOT ADEQUATELY CLASSIFY.
3. HORIZONTAL SCALE NOT APPROPRIATE.

LOGS OF
SOUTHERN
STAPLETO
SOUTHERN TIER C

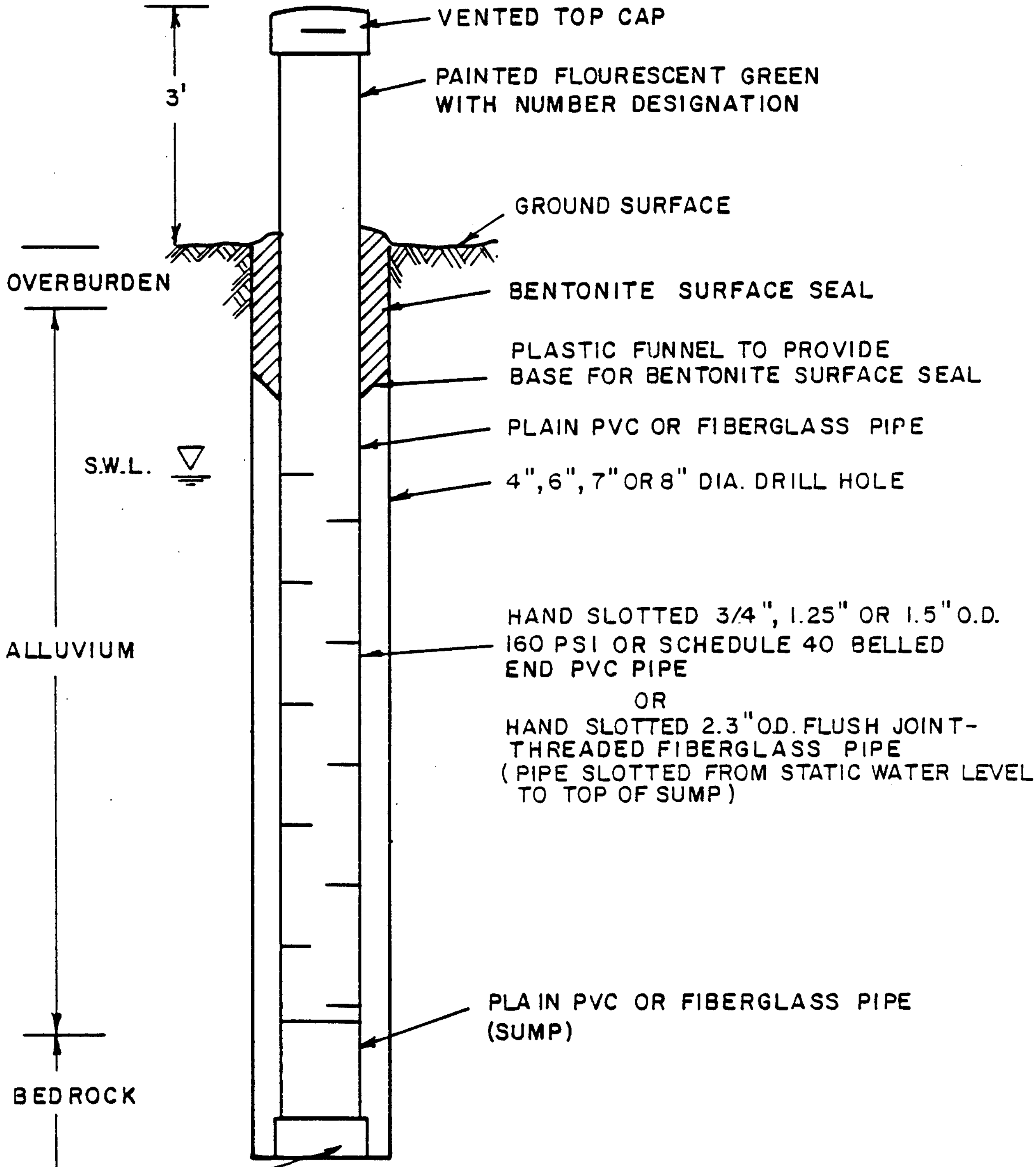


NOTES:

1. SEE FIGURE 6 FOR FULL DEFINITIONS OF SOIL AND BEDROCK CLASSIFICATIONS.
2. NOTES ON LOGS DEFINE SOIL AND BEDROCK CLASSIFICATIONS WHICH STANDARD SYMBOLS DO NOT ADEQUATELY CLASSIFY.
3. HORIZONTAL SCALE NOT APPROPRIATE.

LOGS OF TEST/MONITOR HOLES
SOUTHERN TEST/MONITOR HOLES
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF THE ROCKY MOUNTAIN ARSENAL

blatchley associates, inc.
CONSULTING ENGINEERS

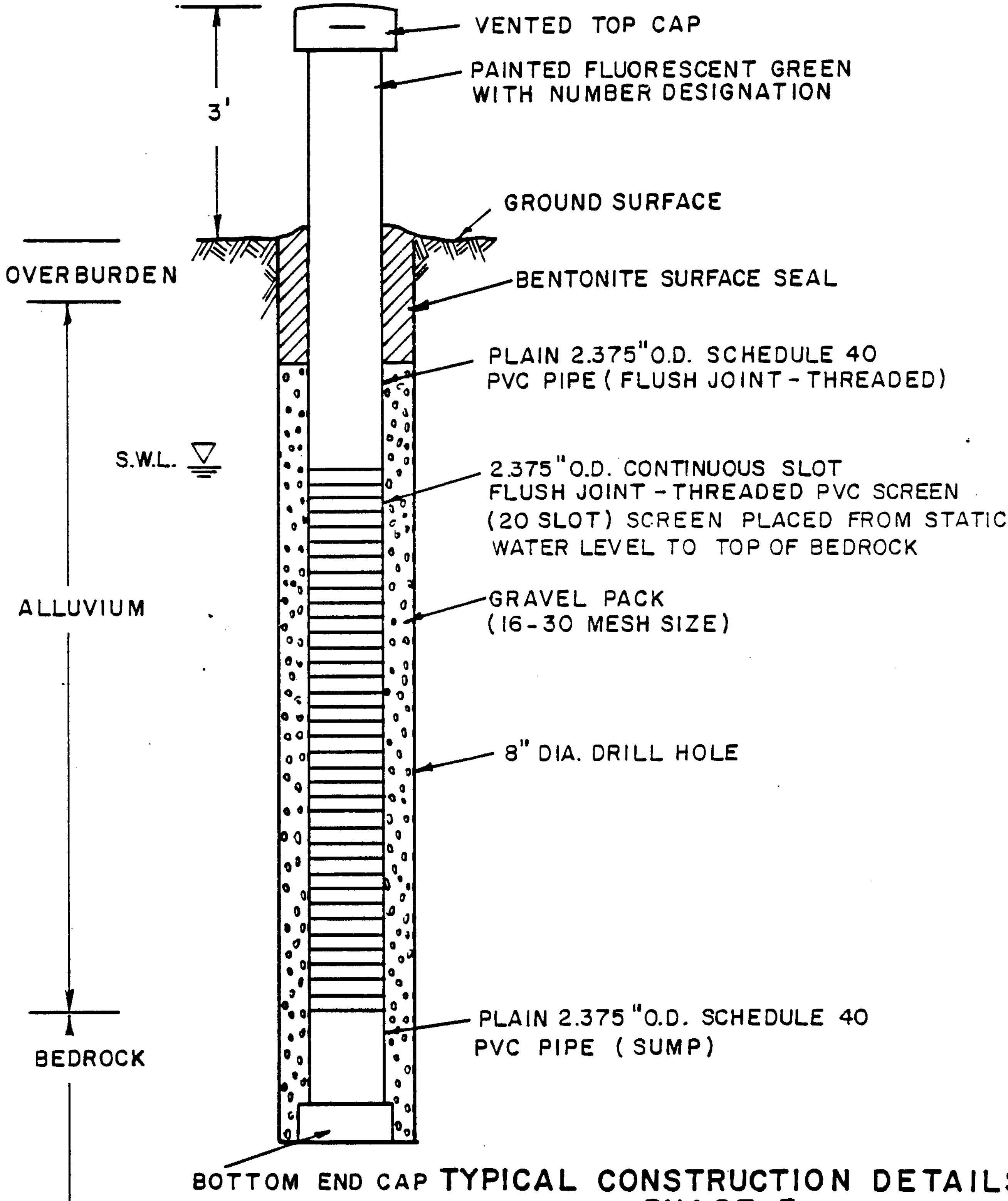


TYPICAL CONSTRUCTION DETAILS
PHASE I AND 2

TEST / MONITOR HOLES
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF R.M.A.

NO SCALE

blatchley associates, inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD, #306
DENVER, COLORADO 80227

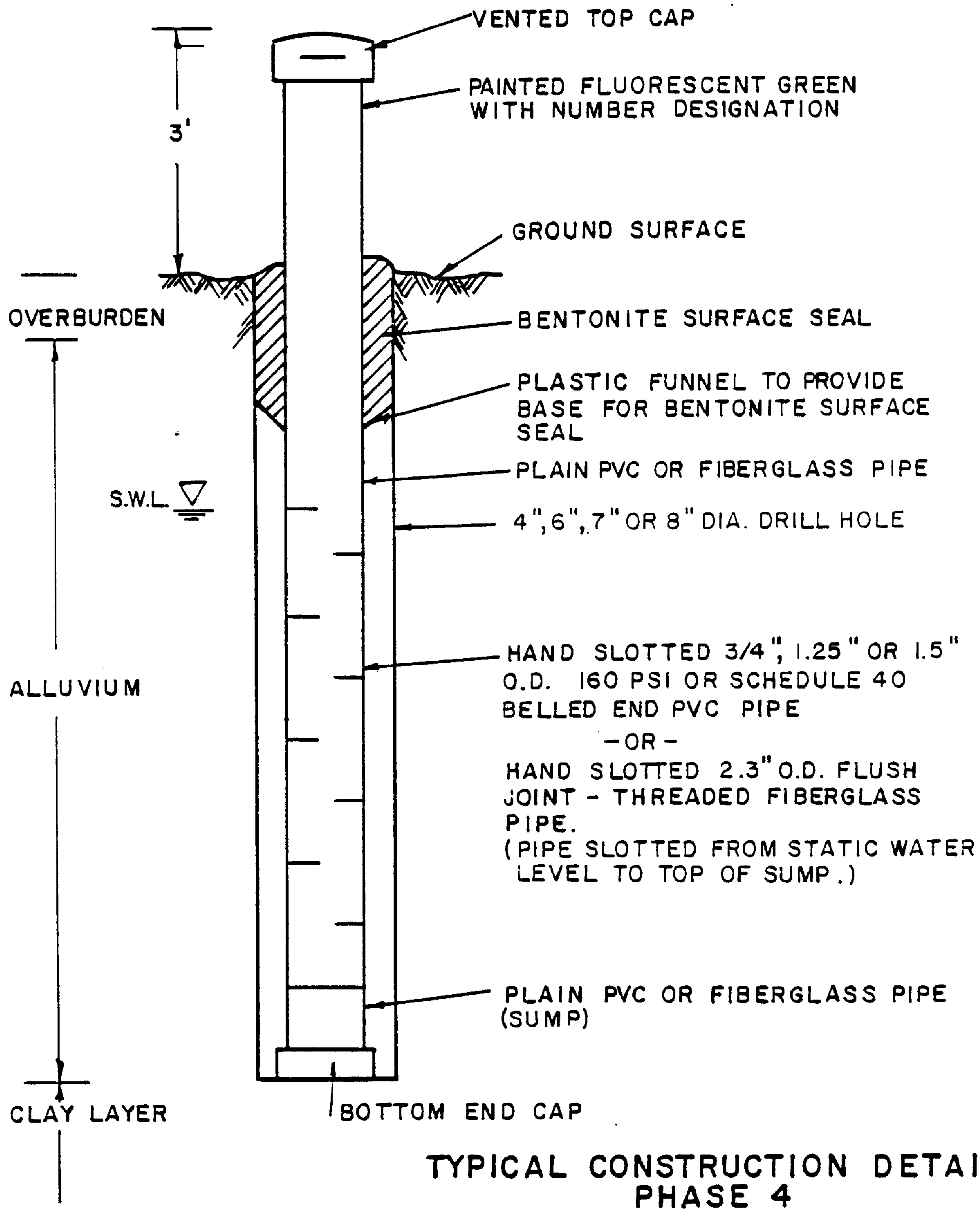


TYPICAL CONSTRUCTION DETAILS
PHASE 3

TEST / MONITOR HOLES
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF R.M.A.

NO SCALE

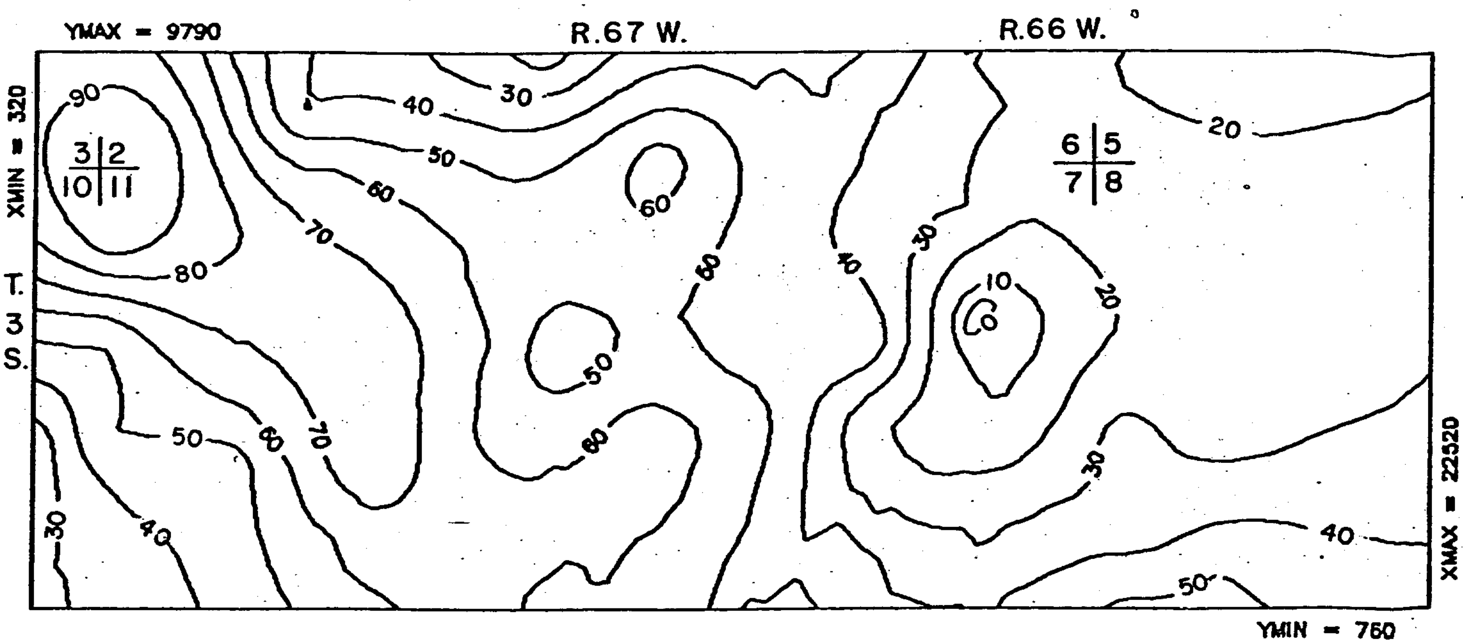
blatchley associates, inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD, #306
DENVER, COLORADO 80227



TYPICAL CONSTRUCTION DETAILS
PHASE 4
TEST / MONITOR HOLES
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF R.M.A.

NO SCALE

blatchley associates, inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD, #308
DENVER, COLORADO 80227



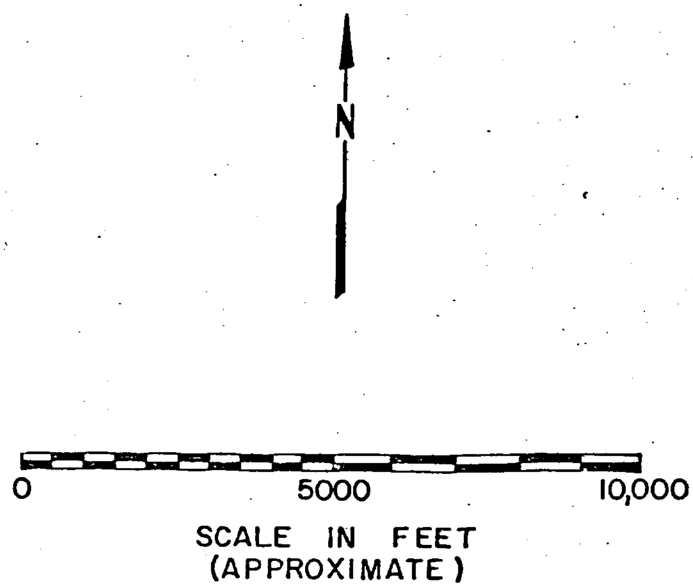
LEGEND

3|2 10|11 Section Corner

50 Contour Lines Drawn Through Points Of Equal Depth To Bedrock From Ground Surface. Contour Interval 10 Feet

FIGURE 9

XMAX = 22520



DEPTH TO BEDROCK CONTOUR MAP
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, inc.
CONSULTING ENGINEERS
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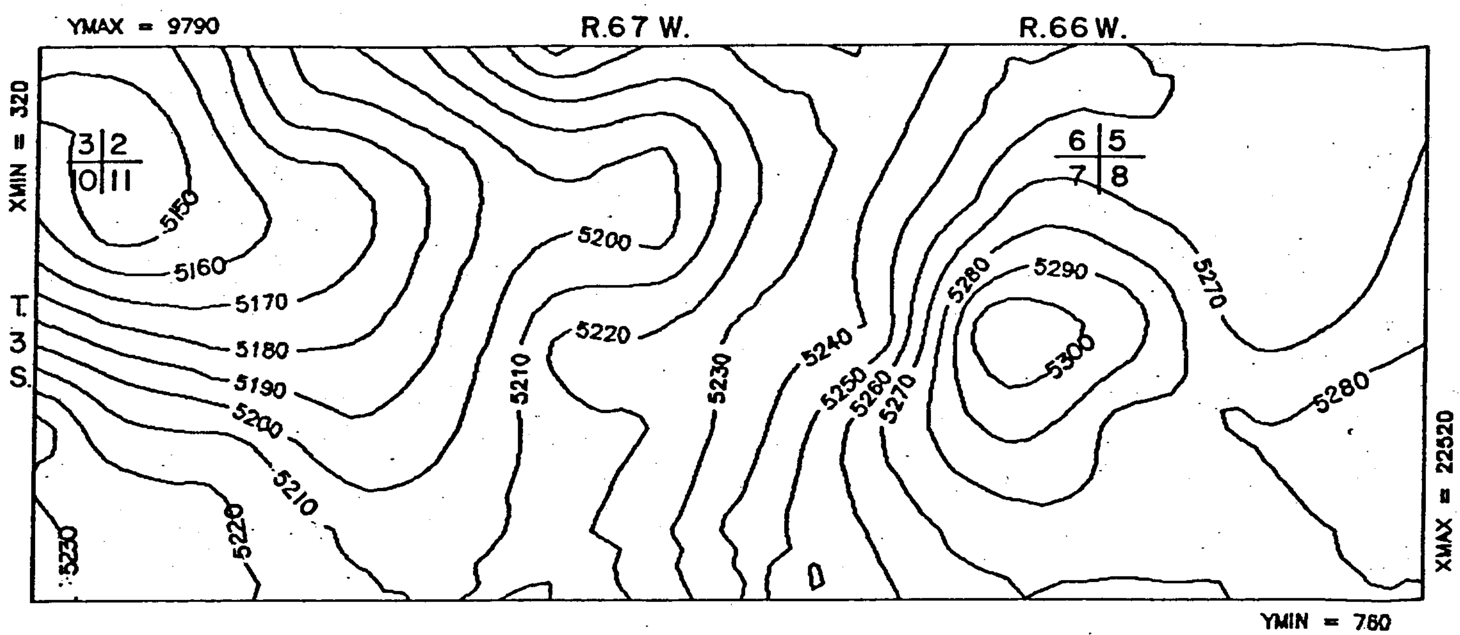
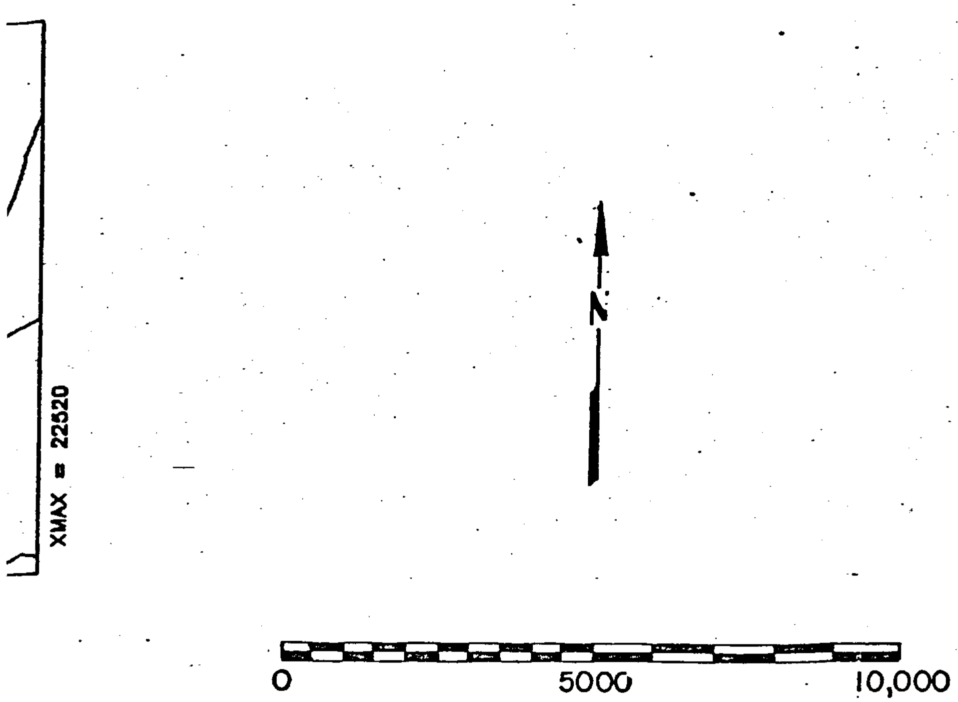
DENVER, COLORADO 80227



LEGEND

3 | 2 / 10 | 11 Section Corner

5210 Contour Line Drawn Through Points Of Equal Elevation Of The Top Of Bedrock Contour Interval 10 Feet. Datum Is Mean Sea Level.



BEDROCK CONTOUR MAP
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, Inc.
CONSULTING ENGINEERS
2_5 SOUTH WADSWORTH BOULEVARD, #306
DENVER, COLORADO 80227

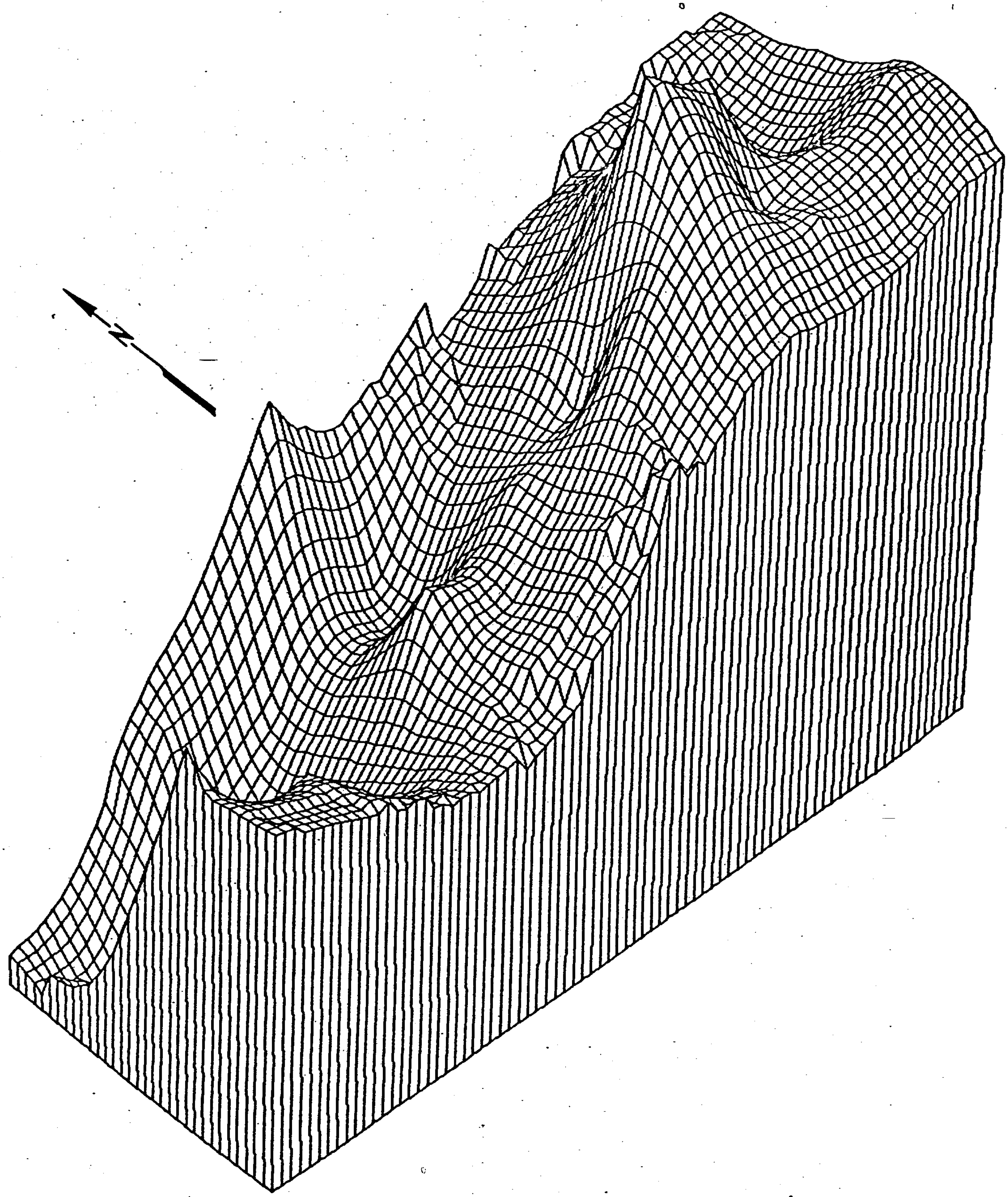

N

FIGURE II

NOTES:

1. Block Diagram Of Bedrock Surface As Viewed From Immediatly Southwest Of Test / Monitor Hole 10-2 (Closest Corner To The Observer).
2. Drawn On Elevation Of Bedrock
3. Angle Of Rotation Is 225 Degrees
4. Angle Of Observation Is 45 Degrees
5. Height To Width Ratio Is 0.5

THREE DIMENSIONAL
BEDROCK SURFACE BLOCK DIAGRAM
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

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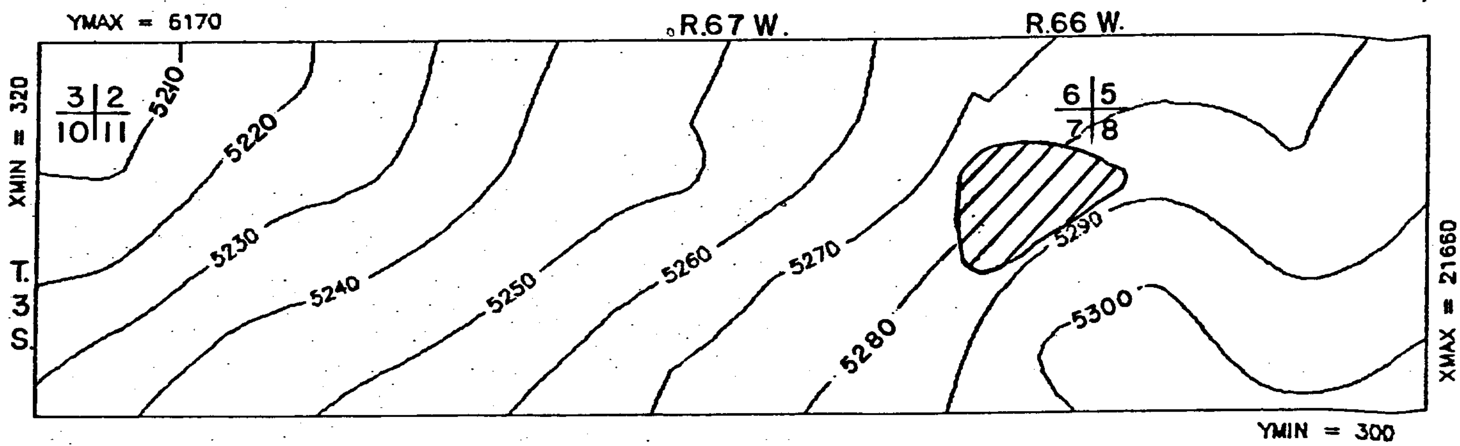
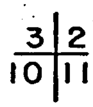
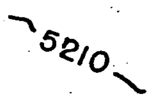
DENVER, COLORADO 80227



LEGEND



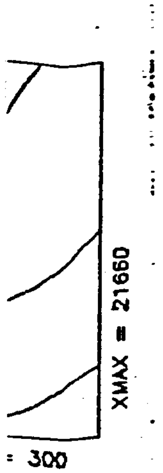
Section Corner

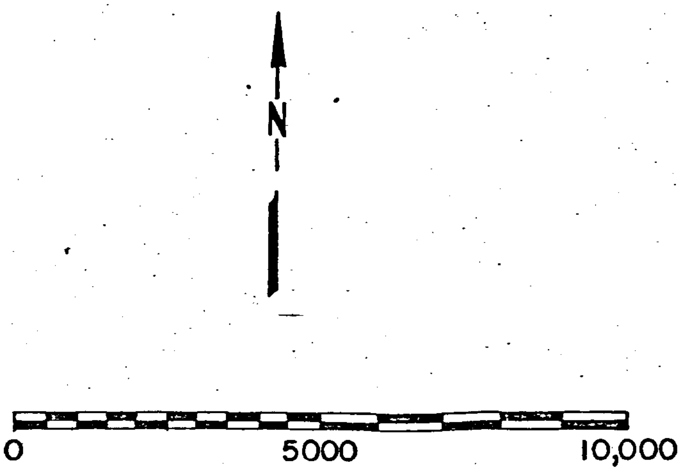


Contour Line Drawn Through Points Of Equal Elevation Of Water Table. Contour Interval 10 Feet. Datum Is Mean Sea Level.


Indicates Area Where Alluvium Is Unsaturated.

FIGURE 12

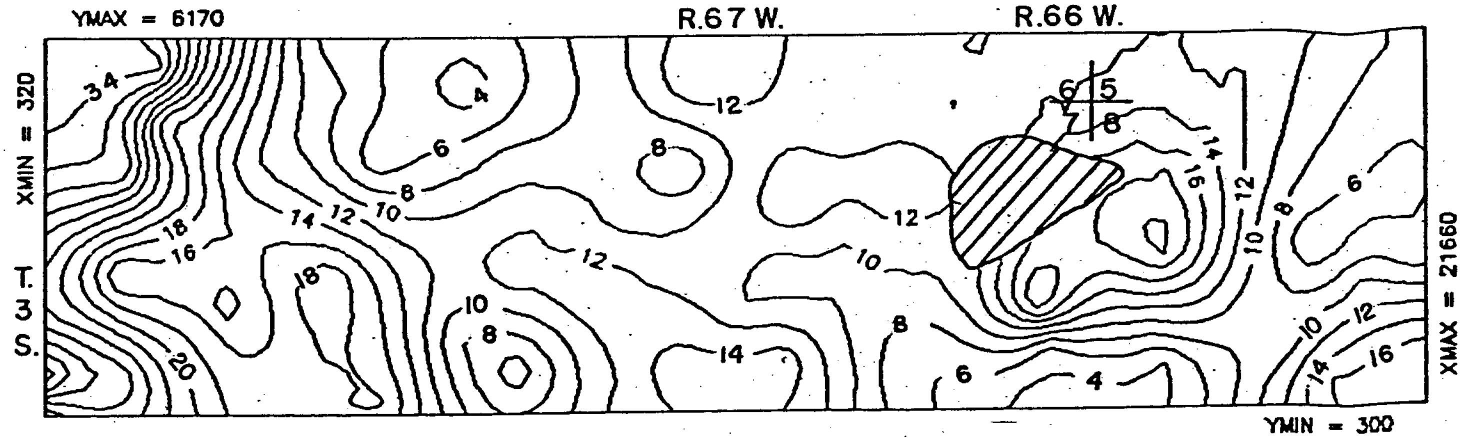




SCALE IN FEET
(APPROXIMATE)

EXISTING WATER TABLE ELEVATION
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD, #306
DENVER, COLORADO 80227

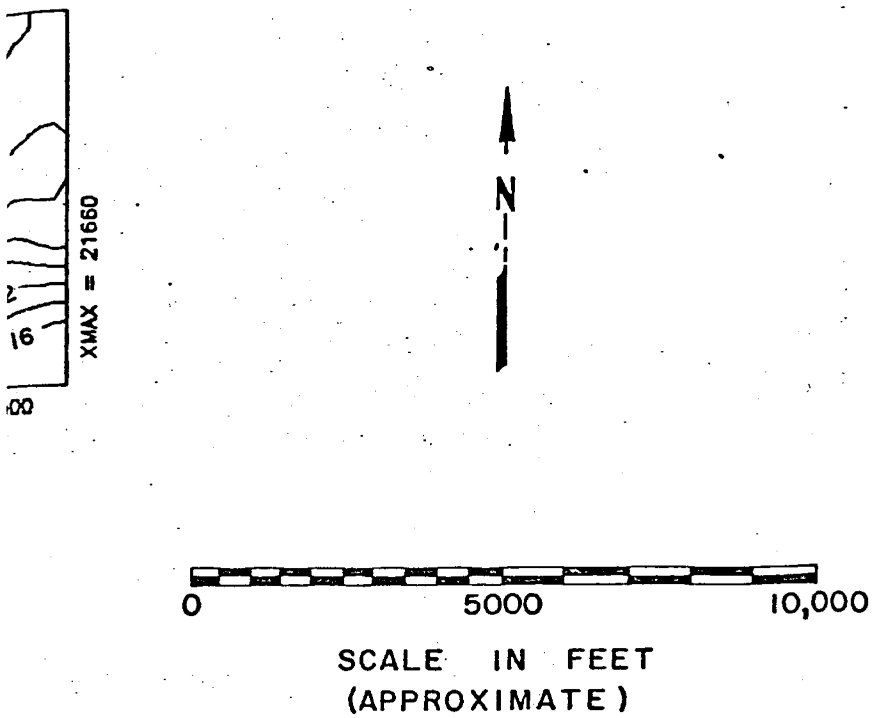


LEGEND

6 | 5
7 | 8 Section Corner

16 Contour Line Drawn On Points Of Equal Depth To Water Table Below Existing Ground Level. Contour Interval 10 Feet.

Indicates Area Where Alluvium Is Unsaturated.



EXISTING DEPTH TO WATER TABLE
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

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CONSULTING ENGINEERS
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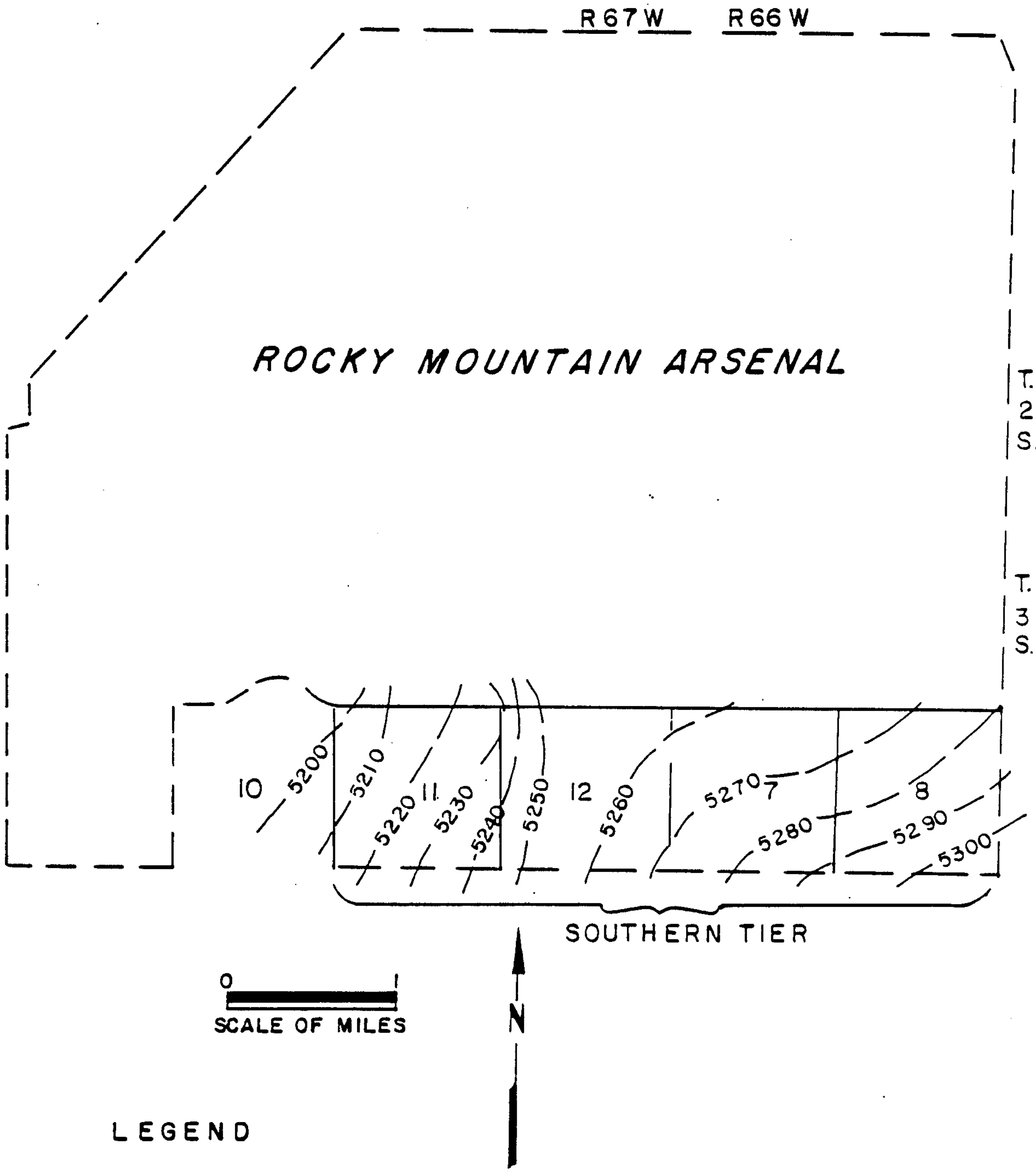
DENVER, COLORADO 80227



LEGEND

5210 Contour Line Drawn Through Points Of Equal Elevation Of Water Table. Dashed Where Approx. Located. Contour Interval 10 Feet. Datum Is Mean Sea Level.

Note: Adapted From Smith et. al., 1964

1957
WATER TABLE ELEVATION
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, inc.
CONSULTING ENGINEERS
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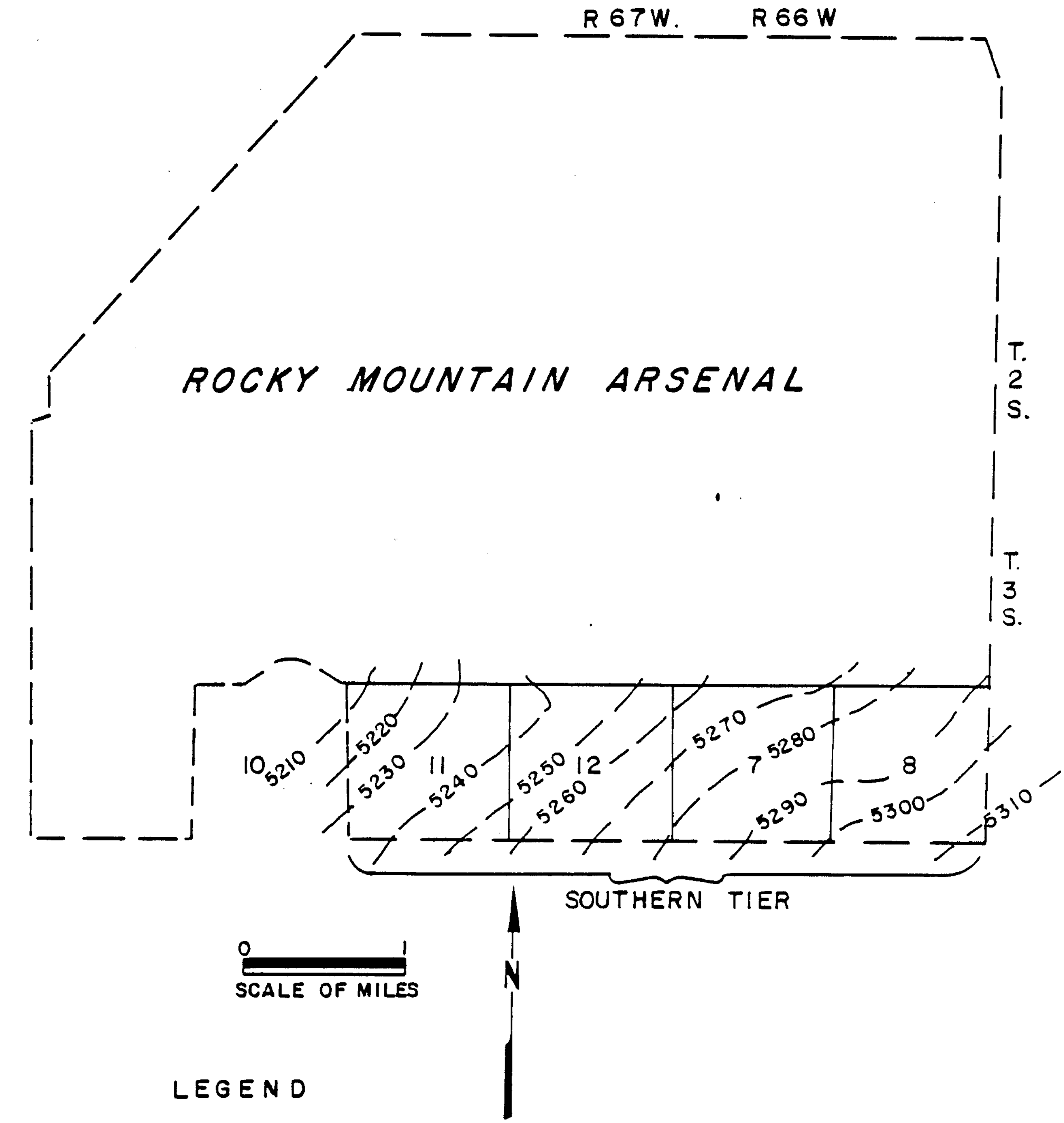
DENVER, COLORADO 80227



LEGEND

5210 Contour Line Drawn Through Points Of Equal Elevation Of Water Table. Dashed Where Approx. Located. Contour Interval 10 Feet. Datum Is Mean Sea Level.

Note: Adapted From Romero And Ward, 1981

1981
WATER TABLE ELEVATION
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates. inc.
CONSULTING ENGINEERS
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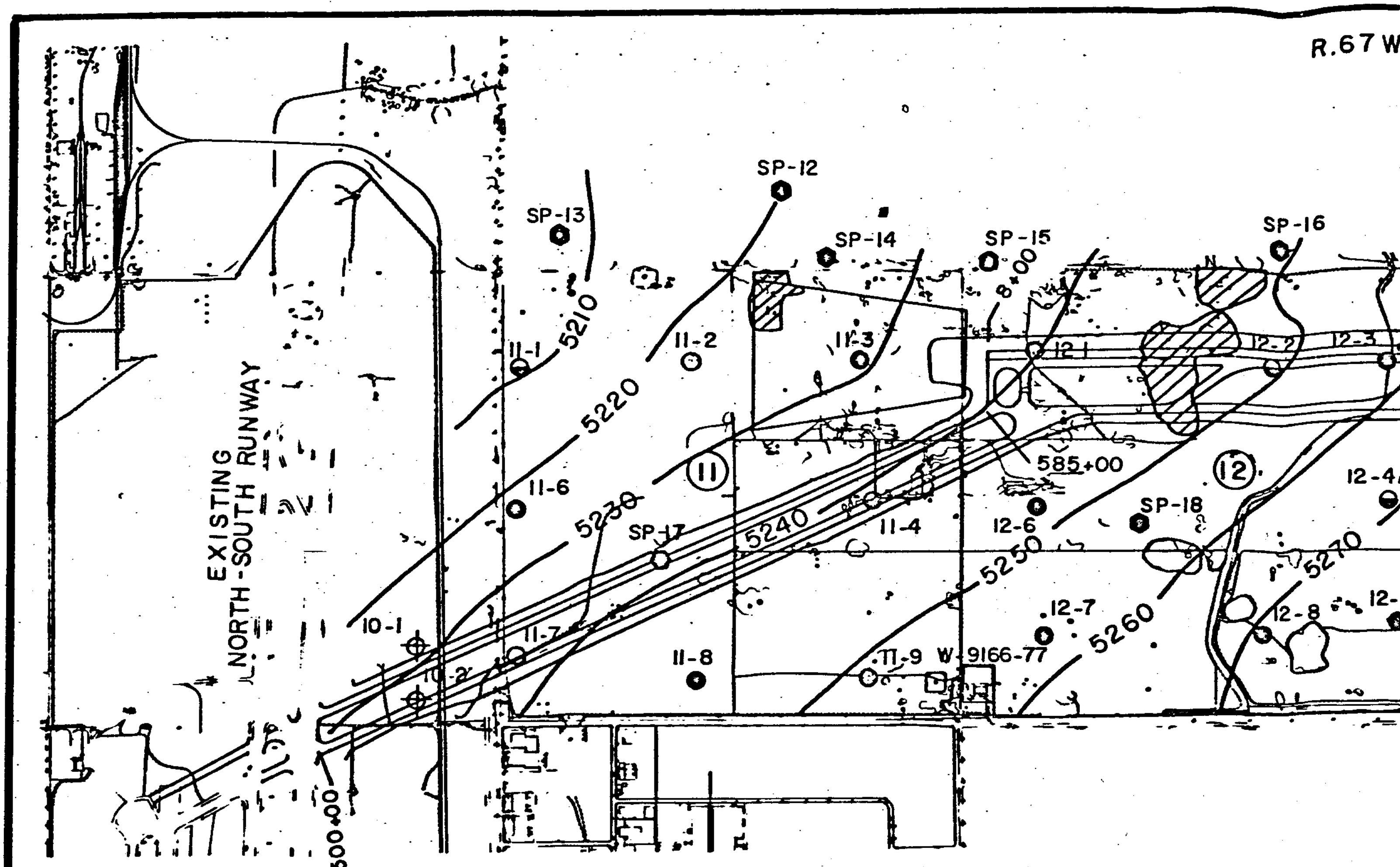
DENVER, COLORADO 80227



LEGEND

11-2, 11-3, 11-1, 10-1 — New Test/Monitor Holes With Identifying Numbers

SP-13, DM-9 — Pre-Existing Monitor Holes With Identifying Numbers

5260 — Contour Lines Drawn Through Points Of Equal Elevation Of Water Level, Contour Interval 10 Feet Datum Is Mean Sea Level.

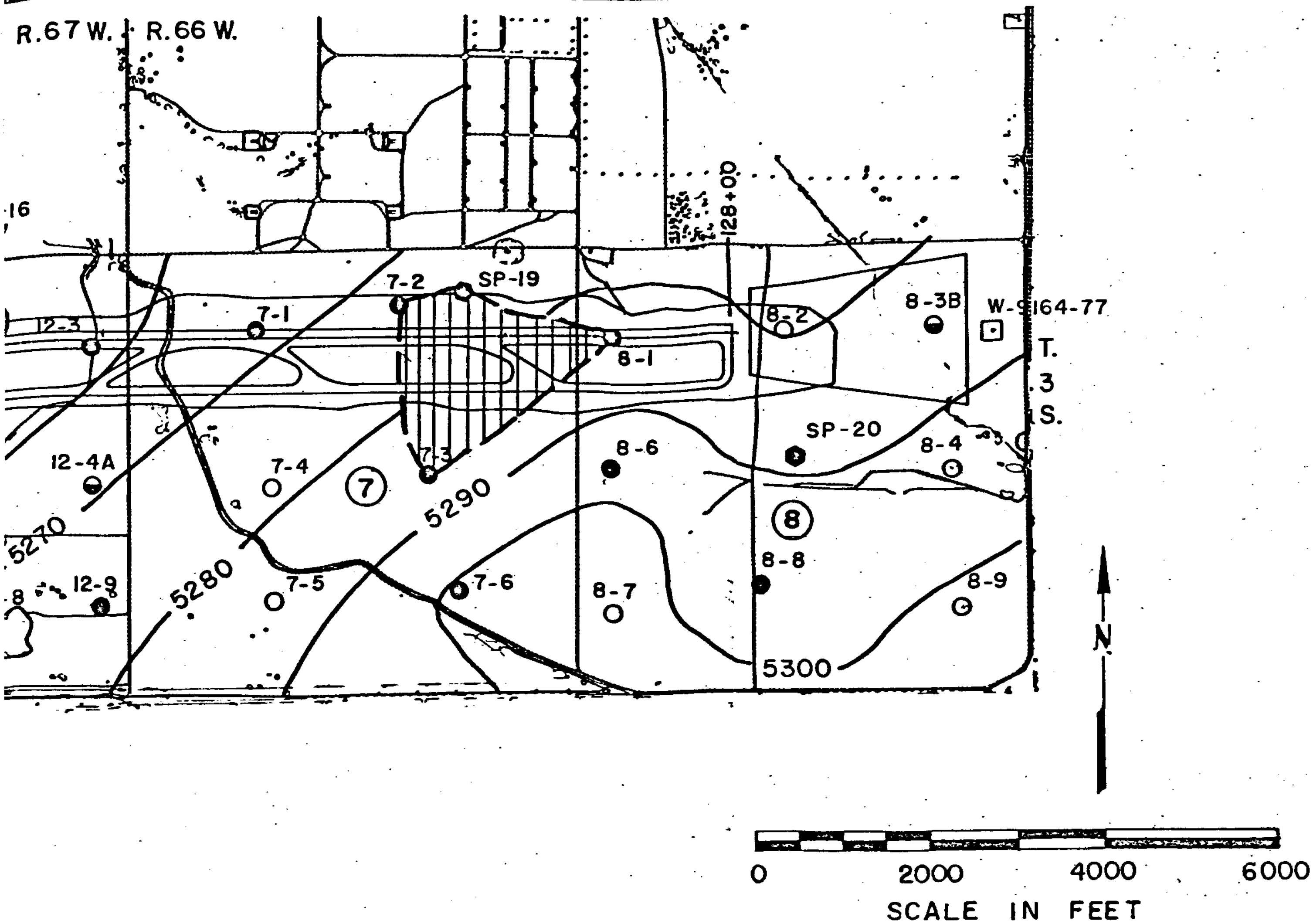
Area Where Alluvium Is Unsaturated.

Area Of Known Contamination

Section Number

W-9166-77
Existing Shallow Alluvial
Identifying Water Court Cas

128+00
Stationing Number, Station
Alignment Taken From July 2
By Centennial Engineering, In

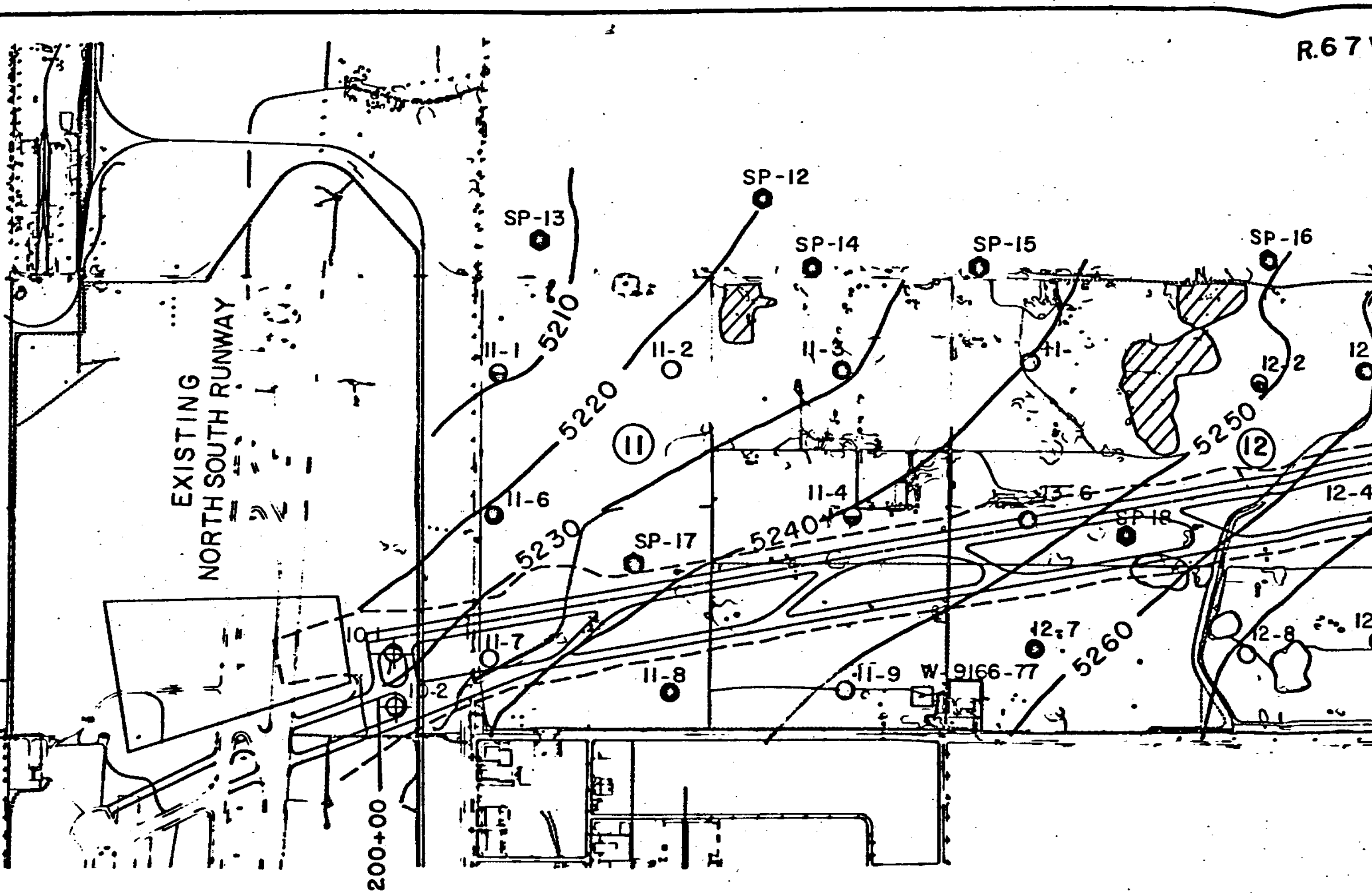


lluvial Well With
urt Case Number.

Stationing Along Northern
n July 24,1985 Map Provided
ering, Inc.

NORTHERN ALIGNMENT
LOCATION MAP
AND
EXISTING ELEVATION OF WATER TABLE
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

blatchley associates, Inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD. #306
DENVER, COLORADO 80227



LEGEND

11-2, 11-3, 11-1, 10-1 — New Test/Monitor Holes With Identifying Numbers

SP-13, DM-9 — Pre-Existing Monitor Holes With Identifying Numbers

5260 — Contour Lines Drawn Through Points Of Equal Elevation Of Water Level. Contour Interval 10 Feet. Datum Is Mean Sea Level.

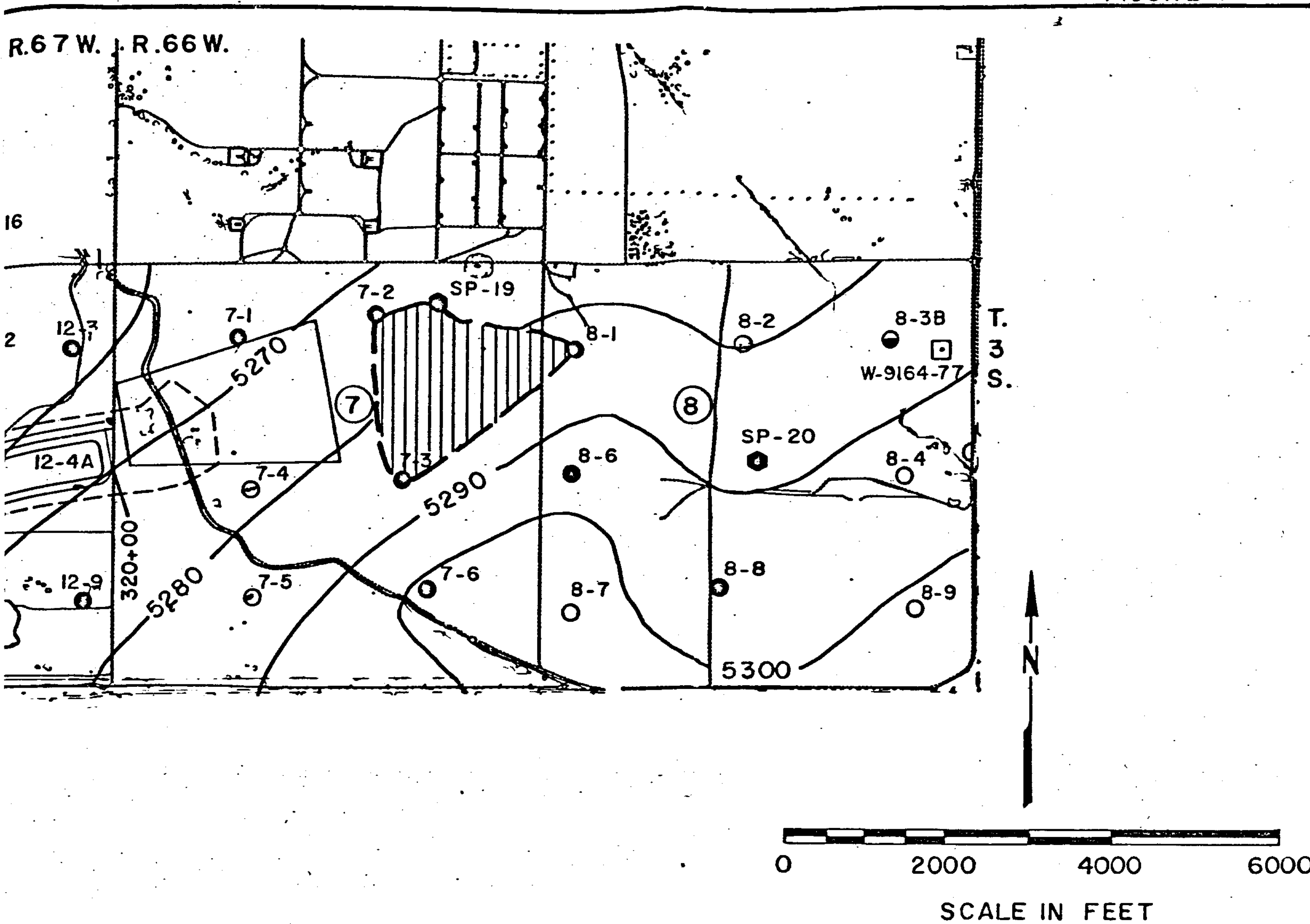
Area Where Alluvium Is Unsaturated.

Area Of Known Contamination

11 — Section Number

W-9166-77 — Existing Shallow Alluvi
Identifying Water Cour

200+00 — Stationing Number, Stati
Taken From July 24, 19
Centennial Engineering;



Alluvial Wall With
r Court Case Number.

, Stationing Along Alignment C
24, 1985 Map Provided By
ering, Inc.

ALIGNMENT C
LOCATION MAP
AND
EXISTING ELEVATION OF WATER TABLE
STAPLETON INTERNATIONAL AIRPORT
SOUTHERN TIER OF ROCKY MOUNTAIN ARSENAL

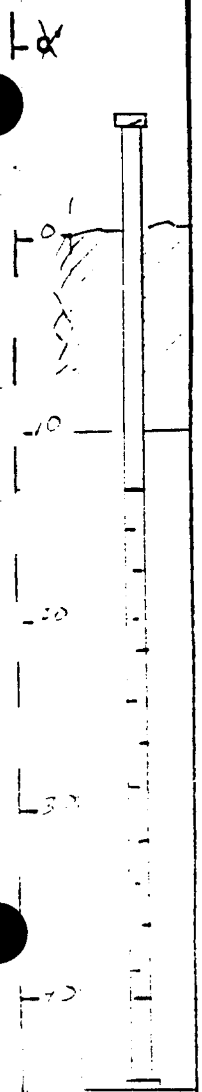
blatchley associates, Inc.
CONSULTING ENGINEERS
2525 SOUTH WADSWORTH BOULEVARD #306
DENVER, COLORADO 80227

APPENDIX A

Test/Monitor Hole Completion Summaries

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ ELEVATION · GROUND LEVEL ≈ 52.63

TOP OF CASING 3.26' A.G.L.

10-1

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 45

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 4" continuous flight auger

DRILLING FLUID None

SAMPLING METHOD California grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/24/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ___

CASING STRING: C = casing; S = screen

0 - 13	C	
13 - 40	S	
40 - 45	C	

CASING:

MATERIAL PVC

DIMENSIONS 1¼" bolted glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1¼"

SLOT SIZE ± 1/16" x 1¼" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'.

MISCELLANEOUS:

3 Alum cap, locked lug cap

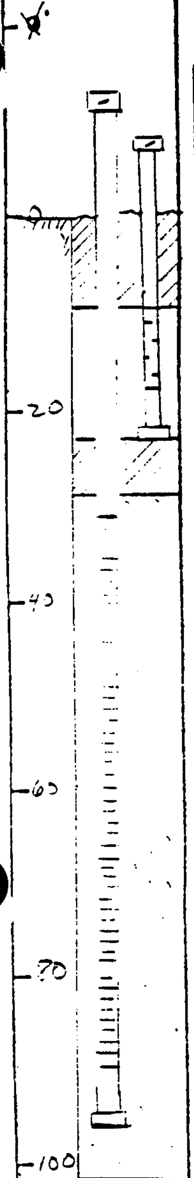
W.L.

6/24/85 35

7/16/85 32.07

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ 11-1

ELEVATION: GROUND LEVEL 5241.6
TOP OF CASING 2" 2.90' A.G.L.
3/4" 2.32' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 101'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD Split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 11-1 drilled completed potential perched water

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/15/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD [illegible]

ADDITIVES [illegible]

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

2" PVC			3/4" PVC		
0	31	C	0	10	C
31	91	S	10	18	S
91	96	C	18	23	C

CASING:
MATERIAL PVC PVC
DIMENSIONS 2" Flush Joint Threaded 3/4" Belled Glued

SCREEN:
MATERIAL PVC PVC
DIMENSIONS 2" 3/4"
SLOT SIZE 20 ± 1/16 x 1 1/2" saw cut

PACKERS Saw cut
Paper packing @ 10'

CENTRALIZERS None

GRAVEL PACK to 29.2' B.T.O.C
#16-30 Sand

CEMENT Bentonite 29.2' to 23'
Bentonite 0 to 10'

MISCELLANEOUS:

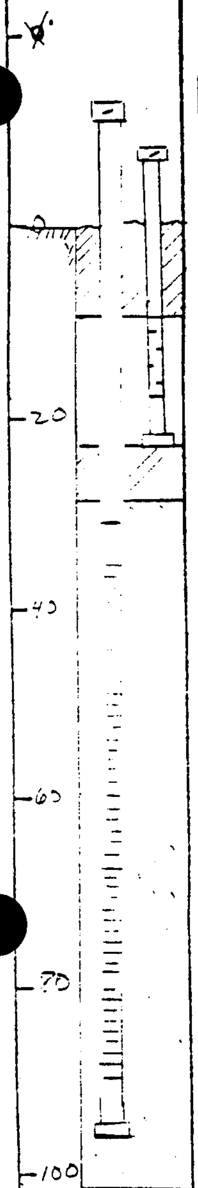
Bottom cap, Vented top cap, painted florescent green metal tag w/number designation

W.L (2")
6/15/85 32.5'
7/16/85 32.54'

W.L (3/4")
7/9/85 Dry
7/16/85 10.18'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ________ 11-1

ELEVATION: GROUND LEVEL 5241.6

TOP OF CASING 2" 2.90' A.G.L.
3/4" 2.32' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 101'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD Split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 11-1 drilled completed potential perched water

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/15/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

2" PVC			3/4" PVC		
0	31	C	0	10	C
31	91	S	10	18	S
91	96	C	18	23	C

CASING:

MATERIAL PVC PVC

DIMENSIONS 2" Flush Joint Threaded 3/4" Belled Glued

SCREEN:

MATERIAL PVC PVC

DIMENSIONS 2" 3/4"

SLOT SIZE 20 ±1/16" 1 1/2" saw cut

PACKERS Saw cut

Paper packing @ 10'

CENTRALIZERS None

GRAVEL PACK to 29.2' B.T.O.C
#16-30 Sand

CEMENT Bentonite 29.2' to 23'
Bentonite 0 to 10'

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

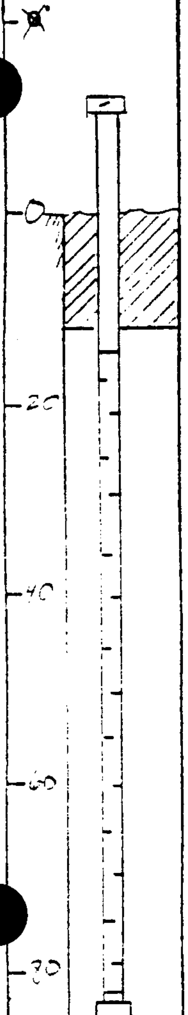
Bottom cap Vented top cap, painted florescent green metal tag w/number designation

W.L (2")
6/15/85 32.5'
7/16/85 32.54'

W.L (3/4")
7/9/85 Dry
7/16/85 10.18'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ 11-2

ELEVATION: GROUND LEVEL 5235.6

TOP OF CASING 2.93' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 85'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	5/14/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 15	C	
15 – 83	S	
83 – 85	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ±1/16" x 1½", saw cut

PACKERS plastic funnel @ ±12'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to ±12'

MISCELLANEOUS:

Bottom plug [illegible] top cap painted fluorescent green [illegible] for injection [illegible]

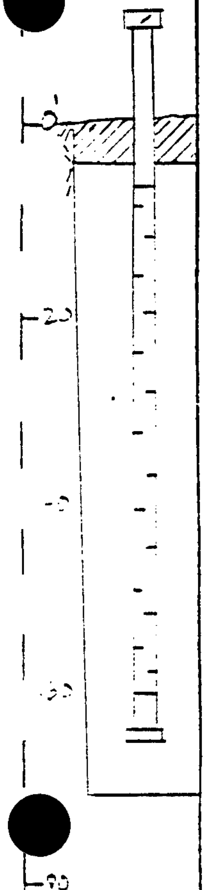
WL

5/14/85 15'

7/16/85 15.07'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ________ ELEVATION: GROUND LEVEL 5233.5

TOP OF CASING 2.99' A.G.L.

11-3

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 70.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hallow auger

DRILLING FLUID None

SAMPLING METHOD Split spoon, California, grab.

SURFACE CASING

COMMENTS (problems, shutdowns, etc.) pipe sticking in auger when removing auger - had to cut off 3.9' of pipe

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/22/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 7.2	C	
7.2 - 60.2	S	
60.2 - 65.2	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.3"

SLOT SIZE ±1/16" X 1½" saw cut

PACKERS Plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

MISCELLANEOUS:

Saxon plug vented top cap

painted Florescent green, metal tag w/number designation

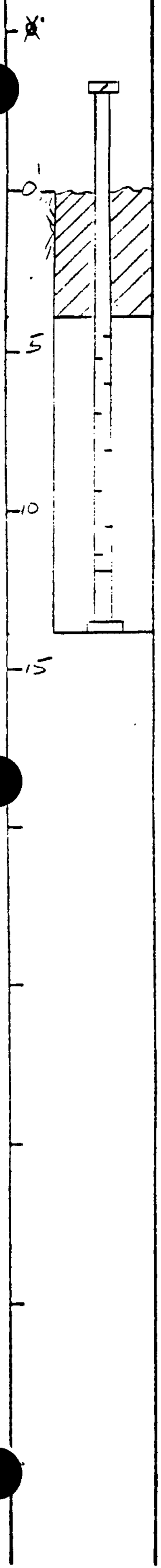
W.L.

5/22/85 5'

7/16/85 5.81'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________ 11-3 A

ELEVATION: GROUND LEVEL 5233.5

TOP OF CASING 2.93' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 14'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD slough sampler, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/12/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD

ADDITIVES

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 4.5	C	
4.5 - 12	S	
12 - 14	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" Belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

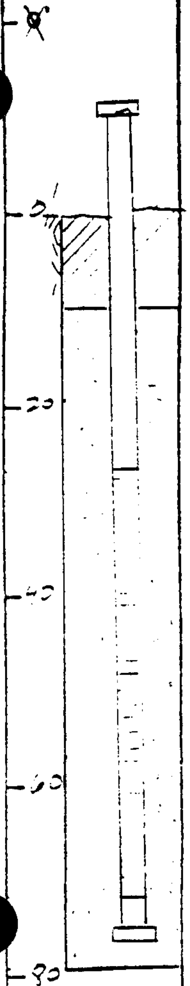
MISCELLANEOUS:

Bottom cap, vented top cap
painted florescent green metal
tag w/number designation

W.L.
6/12/85 9'
7/16/85 5.62'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______________ ELEVATION: GROUND LEVEL 5254.7
TOP OF CASING 2.98' A.G.L.

11-4A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 79.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 8" hollow auger

DRILLING FLUID air, clean water

SAMPLING METHOD None

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)
Test hole 11-4 abandoned and plugged due to broken casing, caving hole
Didn't add gravel pack until after auger pulled, hole caved to 10' B.G.L.

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/14/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ___

CASING STRING: C = casing ; S = screen

0 – 27	C	
27 – 72	S	
72 – 77	C	

CASING:
MATERIAL PVC
DIMENSIONS 2" Flush Joint, Threaded

SCREEN:
MATERIAL PVC
DIMENSIONS 2"
SLOT SIZE 20

PACKERS None

CENTRALIZERS None

GRAVEL PACK natural gravel pack to 10' B.G.L

CEMENT Bentonite 0 to 10'.

DEVELOPMENT:

METHOD Bailer surge block

ADDITIVES None

RESULTS

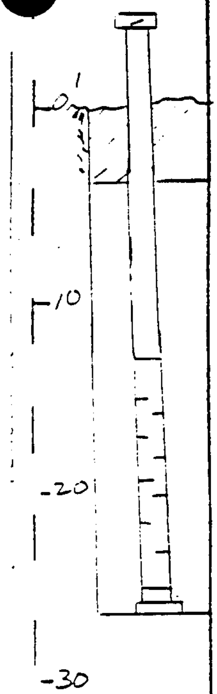
MISCELLANEOUS:

Bottom cap, vented top cap, painted florescent green metal tag w/number designation

W.L.
6/14/85 14.5'
7/16/85 15.04'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ ELEVATION: GROUND LEVEL 5248.5

TOP OF CASING 3.00' A.G.L.

11-5

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 26.5'

DRILLING CONTRACTOR Geotechnic Exploration Co

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 7" hollow auger

DRILLING FLUID None

SAMPLING METHOD Split spoon, California grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 11-5 not drilled to bedrock. Test hole drilled for soils investigation only. Although completed w/PVC water level measurement not being taken

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/19/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 13.2	C	
13.2 - 25.2	S	
25.2 - 26.2	C	

CASING:

MATERIAL PVC

DIMENSIONS 3/4" Belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 3/4"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

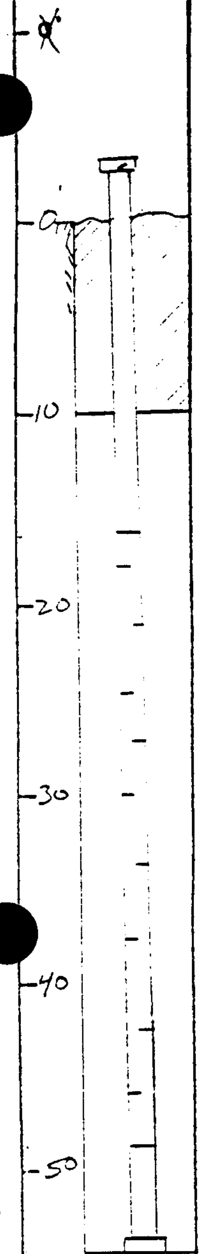
Bottom cap. Vented top cap painted florescent green metal tag w/number designation

W.L.

6/19/85 9'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________ ELEVATION: GROUND LEVEL 5334.8

TOP OF CASING 2.91' A.G.L.

11-6

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 54.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	5/20/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ____ Geophysical Log ____

CASING STRING: C = casing; S = screen

0 – 16.5		C
16.5 – 49.5		S
49.5 – 54.5		C

CASING:

MATERIAL PVC

DIMENSIONS 1 1/2" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1 1/2"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, vented top cap, painted florescent green, metal tag w/number designation

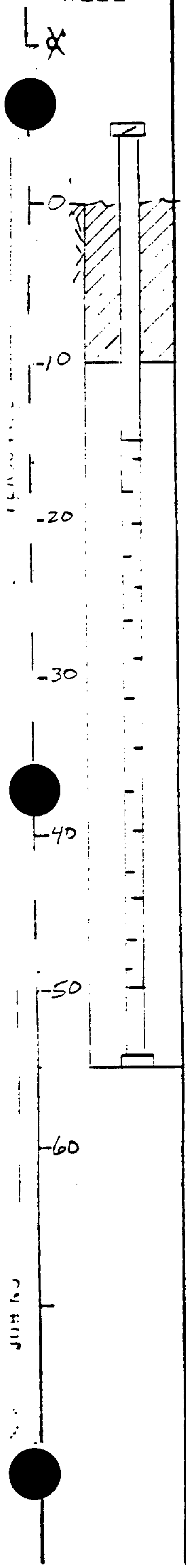
W.L.

5/20/85 14.2'

7/16/85 14.24'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COOR. DATES ______ ELEVATION: GROUND LEVEL 5264.3

TOP OF CASING 3.00' A.G.L.

11-7

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 55'

DRILLING CONTRACTOR Geotechnic Exploration Co

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	4/25/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	15	C			
15	50	S			
50	55	C			

CASING:

MATERIAL PVC

DIMENSIONS 1½" Belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 3/4"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS Plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'.

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

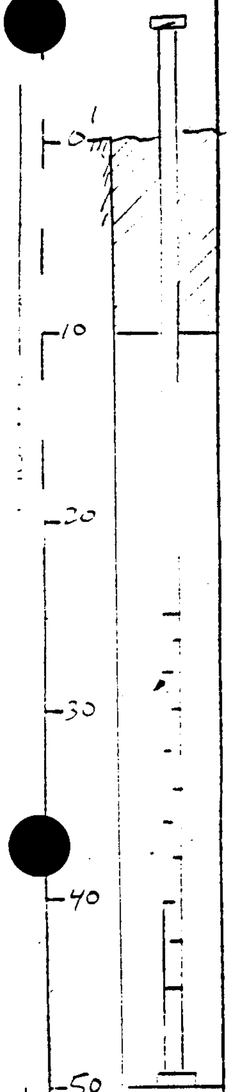
Bottom cap, vented top cap, painted florescent green, metal tag w/number designation

W.L.

4/25/85 31'

7/16/85 28.66'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ____________ 11-8

ELEVATION: GROUND LEVEL 5263.2

TOP OF CASING 3.00' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 50'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, California Grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/20/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 25	C	
25 - 45	S	
45 - 50	C	

CASING:

MATERIAL PVC

DIMENSIONS 1 1/2" Zelled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1 1/2"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'.

MISCELLANEOUS:

Bottom cap, vented top cap painted florescent green metal tag w/ number designation

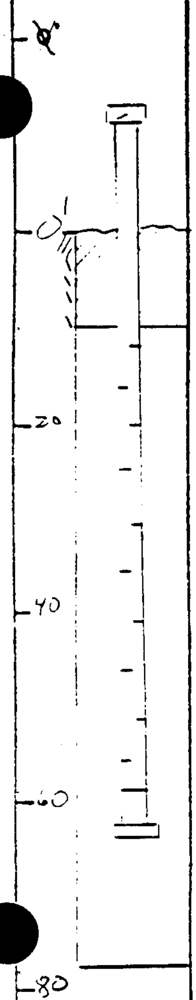
W.L.

5/20/85 17.6'

7/16/85 17.48'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______________ ELEVATION: GROUND LEVEL 5270.1

TOP OF CASING 2.20' A.G.L.

11-9

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 78.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 6" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	4/24/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	10	C
10	59	S
59	64	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" Belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, vented top cap, painted florescent green metal tag w/ number designation

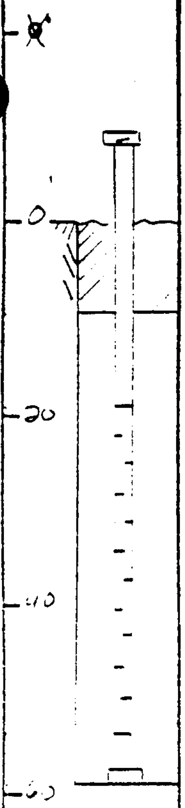
W.L.

4/24/85 19'

7/16/85 17.48'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________ ELEVATION: GROUND LEVEL 5248.1

TOP OF CASING 3.14' A.G.L

12-1

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 59.5'

DRILLING CONTRACTOR Geotechnic Exploration Co

RIG (S) USED CME55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	4/25/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 19.5	C	
19.5 – 54.5	S	
54.5 – 59.5	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom plug, vented top cap, painted florescent green, metal tag w/ number designation

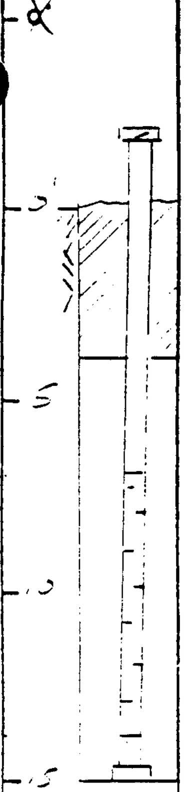
W.L.

4/25/85 18'

7/16/85 8.96'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ ELEVATION GROUND LEVEL 5248.1

TOP OF CASING 3.05' A G.L

12-1A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 15'

DRILLING CONTRACTOR Geotechnic Exploration Co

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD California

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	6/12/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 7.0	C	
7.0 – 14.0	S	
14.0 – 15.0	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint, Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

Bottom plug, vented top cap, painted florescent green, metal tag w/ number designation

W.L.

6/12/85 8.6'

7/16/85 8.96'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL

LOCATION or COORDINATES ______ ELEVATION GROUND LEVEL 5254.4

TOP OF CASING 3.20' A.G.L

12-2

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 63

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD Split spoon California Grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/31/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD Bailer surge block

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 27	C	
27 - 57	S	
57 - 63	C	

CASING:

MATERIAL PVC

DIMENSIONS 2" Flush Joint, Threaded

SCREEN:

MATERIAL PVC

DIMENSIONS 2"

SLOT SIZE 20

PACKERS None

CENTRALIZERS None

GRAVEL PACK #16-30 Sand 10 to 63'

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

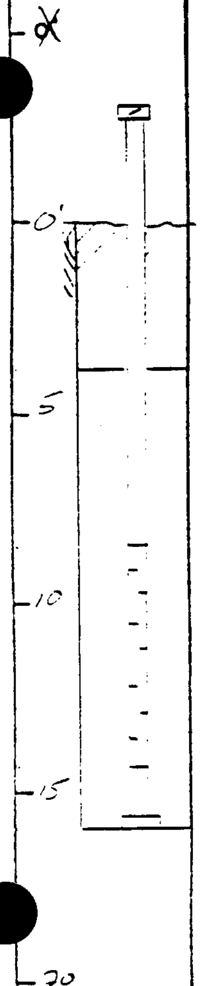
Bottom cap, Vented top cap, painted florescent green, metal tag w/number designation

W.L

5/31/85 10'

7/16/85 7.06

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ________ ELEVATION GROUND LEVEL 5254.4

TOP OF CASING 2.87' A.G.L

12-2A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 16'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/13/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 8.5	C	
8.5 – 14.5	S	
14.5 – 16.0	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

MISCELLANEOUS:

Bottom plug, vented top cap, painted florescent green metal tag w/number designation

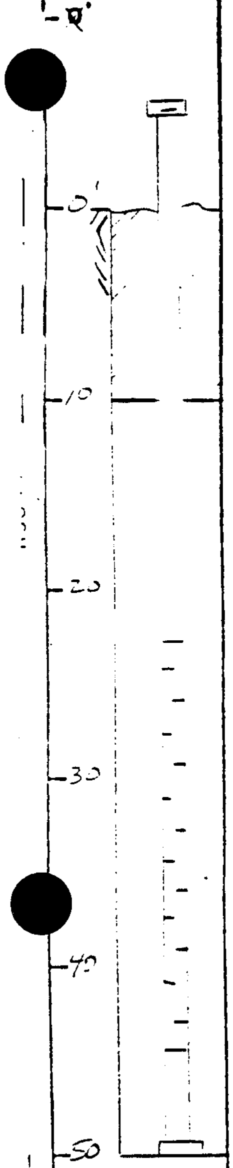
WL

6/13/85 7.3'

7/16/85 7.16'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____ 12-3

ELEVATION: GROUND LEVEL 5266.9

TOP OF CASING 2.46' A.G.L

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 50'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID clean water

SAMPLING METHOD split spoon california grab

SURFACE CASING none

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/17/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 23	C	
23 - 45	S	
45 - 50	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ±1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom plug, vented top cap painted florescent green metal tag w/ number designation

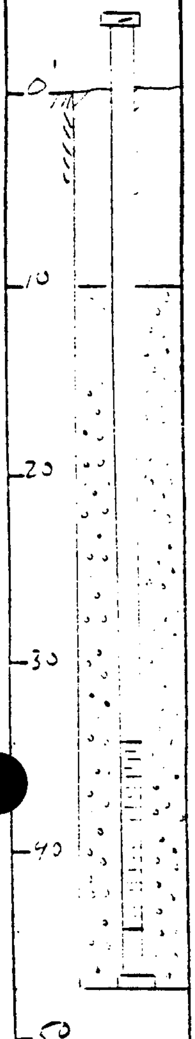
W.L.

5/17/85 10'

7/16/85 12.65'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________ 12-4

ELEVATION: GROUND LEVEL 5378.6

TOP OF CASING 2.98' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 47.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) ____________

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/29/85			
LOGGING				
CASING	5/30/85			
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT	5/30/85			
OTHER:				

DEVELOPMENT:

METHOD Bailer, surge block

ADDITIVES None

RESULTS ____________

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	34.5	C
34.5	44.5	S
44.5	47.5	C

CASING:

MATERIAL PVC

DIMENSIONS 2" Flush Joint Threaded

SCREEN:

MATERIAL PVC

DIMENSIONS 2"

SLOT SIZE 20

PACKERS None

CENTRALIZERS None

GRAVEL PACK 10' to 47.5' #16-30 sand

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, vented top cap, painted florescent green metal tag w/ number designation

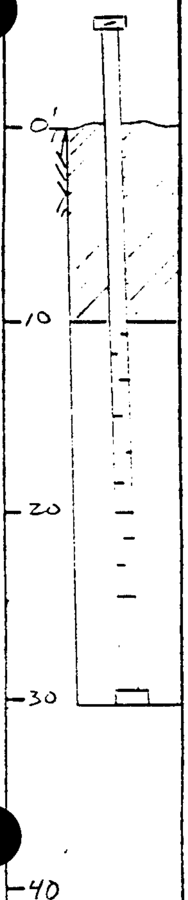
W.L.

5/30/85 9'

7/16/85 9.04'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ 12-5

ELEVATION: GROUND LEVEL 5272.9

TOP OF CASING 3.00' A.G.L

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 30.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon, California grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 12-5 not drilled to bedrock Test hole drilled for soils investigation only. Although completed w/PVC water level measurements not being taken

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/19/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ___

CASING STRING: C = casing ; S = screen

0 – 10	C	
10 – 20	S	
20 – 25	C	

CASING:

MATERIAL PVC

DIMENSIONS 2" Flush Joint, Threaded

SCREEN:

MATERIAL PVC

DIMENSIONS 2"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

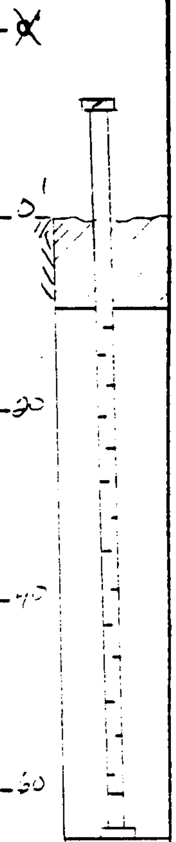
Bottom cap, vented top cap painted florescent green metal tag w/ number designation

W.L

6/19/85 14'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________ 12-6

ELEVATION: GROUND LEVEL 5260.4
TOP OF CASING 2.99' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 65.5'
DRILLING CONTRACTOR Geotechnic Exploration Co.
RIG (S) USED CME 55
SIZES (S) and TYPE (S) of BITS 8" hollow auger
DRILLING FLUID Clean water
SAMPLING METHOD split spoon, California, grab
SURFACE CASING None
COMMENTS (problems, shutdowns, etc.) ____________

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/23/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None
ADDITIVES None
RESULTS ____________

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____
CASING STRING: C = casing ; S = screen

From	To	Type
0	10.5	C
10.5	60.5	S
60.5	65.5	C

CASING:
MATERIAL Fiberglass
DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:
MATERIAL Fiberglass
DIMENSIONS 2.35"
SLOT SIZE ± 1/16" x 1 1/2" Saw cut

PACKERS plastic funnel @ 10'
CENTRALIZERS None
GRAVEL PACK None
CEMENT Bentonite 0 to 10'

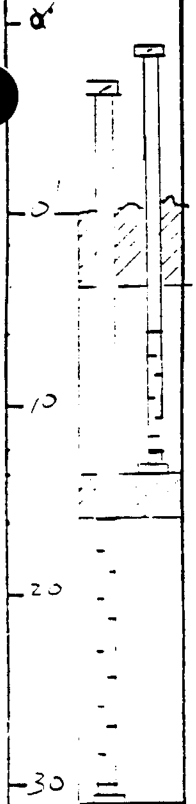
MISCELLANEOUS:

Bottom plug, vented top cap, painted florescent green, metal tag w/ number designation

WL
5/23/85 17'
7/16/85 12.31'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ 12-6A

ELEVATION · GROUND LEVEL 5260.4

TOP OF CASING 2.35" Fiberglass 2.80' A.G. - 3/4" PVC 3.12' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 31'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD Split spoon, California grab.

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 12-6A dual completed to evaluate two potential perched water zones

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/13/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

2.35" Fiberglass			3/4" PVC		
0	16.7	C	0	6.6	C
16.7	30.1	S	6.6	12.9	S
30.1	31.1	C	12.9	13.9	C

CASING:

MATERIAL Fiberglass PVC

DIMENSIONS 2.35" Flush Joint Threaded 3/4" belled glued

SCREEN:

MATERIAL Fiberglass PVC

DIMENSIONS 2.35" 3/4"

SLOT SIZE Fiberglass ± 1/16" x 1½" Saw cut PVC ± 1/16" x 3/4"

PACKERS Plastic funnel @ 16.5 @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4' & 12.5 to 16'

MISCELLANEOUS:

Bottom plug on fiberglass pipe, Bottom cap on PVC both painted florescent green metal tags on each w/ number designations

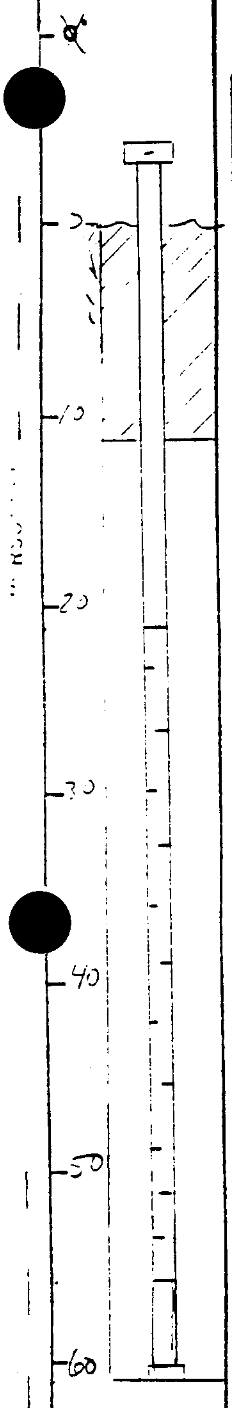
WL

2.35" Fiberglass 7/16/85 13.40'

3/4" PVC 7/16/85 Dry

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ 12-7

ELEVATION · GROUND LEVEL 5262.2

TOP OF CASING 3.08' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 61'

DRILLING CONTRACTOR Geotechnical Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, cal. barrel, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/21/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	21	C
21	56	S
56	61	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½", saw cut

PACKERS plastic funnel @ 11.5'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 11.5'

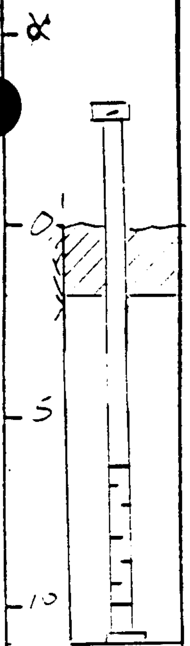
MISCELLANEOUS:

Bottom cap vented top cap painted florescent green, metal tag w/ number designation

W.L.
5/21/85 4'
7/16/85 5.50'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



15

LOCATION or COORDINATES ____________

12-7A

ELEVATION: GROUND LEVEL 5262.2

TOP OF CASING 2.08' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 11

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 7" hollow auger

DRILLING FLUID None

SAMPLING METHOD None

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) ____________

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/21/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS ____________

WELL DESIGN:

BASIS: Geologic Log ____ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	6.5	C
6.5	10.0	S
10.0	11.0	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 2'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 2'

MISCELLANEOUS:

Bottom cap, vented top cap, painted flourescent green, metal tag w/ number designation

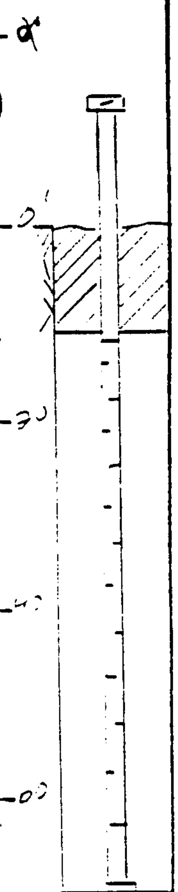
WL

5/21/85 5'

7/16/85 5.49'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ 12-8

ELEVATION: GROUND LEVEL 5285.5

TOP OF CASING 2.72' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 70'

DRILLING CONTRACTOR Geotechnic Exploration Co

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, california, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) ______

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/16/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS ______

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	12	C
12	65	S
65	70	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS Plastic funnel @ 11'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0-to 11'

MISCELLANEOUS:

Bottom cap, vented top cap, painted flourescent green, metal tag w/number designation

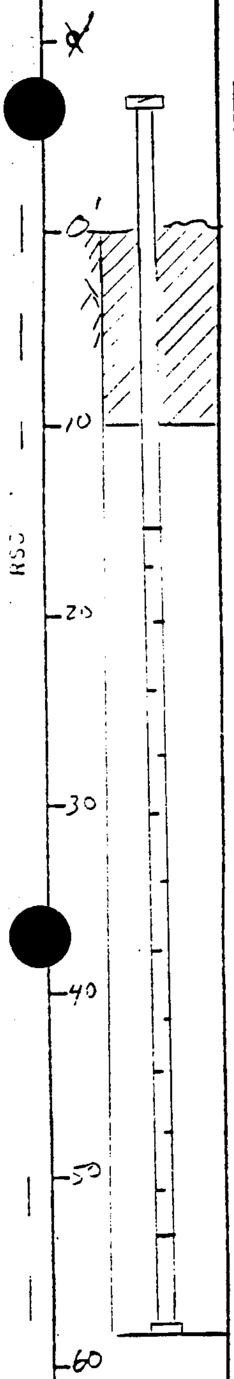
W.L.

5/16/85 16.3'

7/16/85 15.44'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________

12-9

ELEVATION - GROUND LEVEL 5291.2

TOP OF CASING 3.32' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 58.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon california grab.

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/17/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	15.5	C
15.5	53.5	S
53.5	58.5	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'.

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

Bottom cap, vented top cap, painted 1' florescent green metal tag w/ number designation.

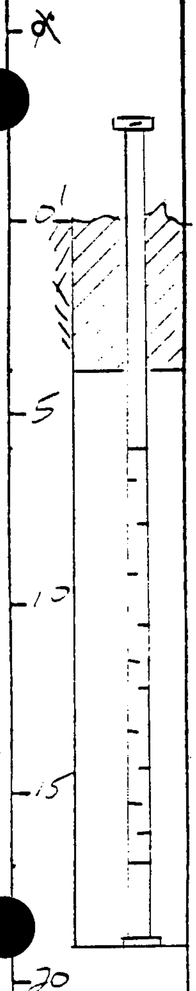
W.L

5/17/85 16.3'

7/16/85 15.25'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____________ 12-9A

ELEVATION · GROUND LEVEL 5291.5

TOP OF CASING 3.07' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 19'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD Grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	6/12/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	5.9	C
5.9	17.0	S
17.0	19.0	C

CASING:

MATERIAL PVC

DIMENSIONS 2" Flush Joint, Threaded

SCREEN:

MATERIAL PVC

DIMENSIONS 2"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

MISCELLANEOUS:

Bottom cap, vented top cap, painted floresent green metal tag w/ number designation

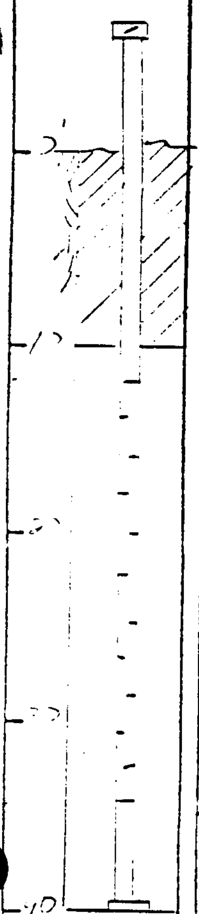
W.L.

6/12/85 17'

7/16/85 15.69'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ________ 7-1

ELEVATION: GROUND LEVEL 5277.6

TOP OF CASING 3.14' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 40'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD [illegible]

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/23/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	12	C
12	35	S
35	40	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" bolted glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" × 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, vented top cap

painted fiberglass screen

metal tag w/ number designation

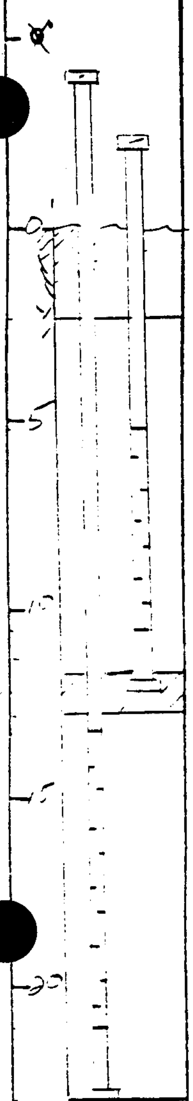
W.L.

5/23/85 11'

7/16/85 12.26'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ ELEVATION GROUND LEVEL 5277.6

TOP OF CASING 2.35" Fiberglass 2.34' A.G.L. 3/4" PVC 3.05' A.G.L.

7-1A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 33'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 7-1A [illegible] two [illegible]

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/13/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

PVC			Fiberglass		
0	13.1	C	0	5.2	C
13.1	31.1	S	5.2	11.2	S
31.1	33	C	11.2	12.2	C

CASING:

MATERIAL PVC Fiberglass

DIMENSIONS 3/4" belled, glued 2.35" Flush Joint Threaded

SCREEN:

MATERIAL PVC Fiberglass

DIMENSIONS 3/4" 2.35"

SLOT SIZE ±1/16" x 3/4" ±1/16" x 1 1/2" saw cut

PACKERS plastic funnels @ 12.8' and 2.5'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 11.3 to 12.8' & 0 to 2.5'

MISCELLANEOUS:

Packers [illegible] Fiberglass [illegible] each, both [illegible] screen [illegible]

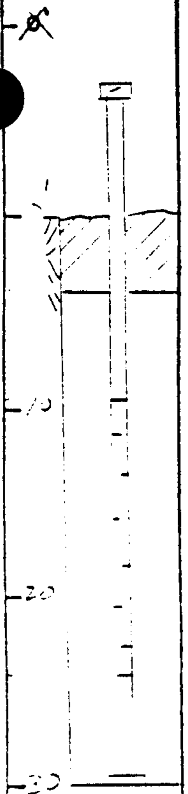
WL.

PVC 6/13/85 15'

7/9/85 12.05'

F.G. Dry

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ ELEVATION GROUND LEVEL 5388.4
TOP OF CASING 2.75' A.G.L.

7-2

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 30'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 4" continuous flight auger

DRILLING FLUID None

SAMPLING METHOD split spoon California grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/7/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	9.5	C
9.5	24.5	S
24.5	29.5	C

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'.

MISCELLANEOUS:

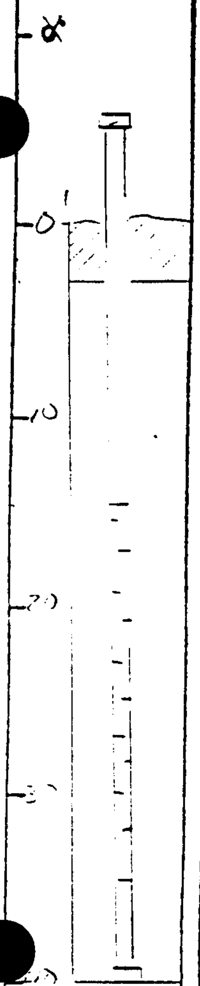
Bottom cap, vented top cap, painted florescent green, metal tag w/ number designation

W.L

6/7/85 Dry

7/16/85 Dry

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ____________ ELEVATION GROUND LEVEL 5315.5

TOP OF CASING 3.17' A.G.L.

7-3

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 40

DRILLING CONTRACTOR Geotechnical Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 4" continuous flight auger

DRILLING FLUID None

SAMPLING METHOD [illegible] continuous core

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/21/85			
LOGGING				
CASING	6/1/85			
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

From	To	Type
0	14.8	C
14.8	34.8	S
34.8	39.8	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" bolted, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 3'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 3'.

MISCELLANEOUS:

Bottom cap, [illegible] top cap, [illegible] fluorescent green [illegible] tag w/ number designation

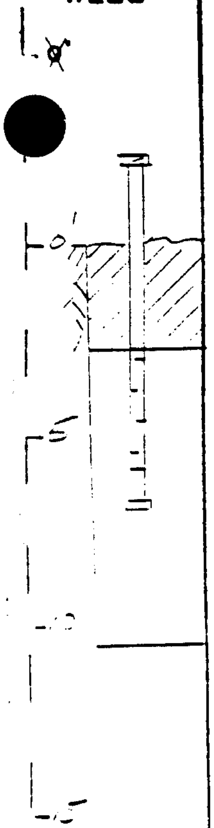
W.L.

5/21/85 Dry

7/16/85 Dry

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES __________ 7-3A

ELEVATION GROUND LEVEL 531.5'
TOP OF CASING 3.15' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 10.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/24/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing; S = screen

0 - 3	C	
3 - 6	S	
6 - 7	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 3'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 3'

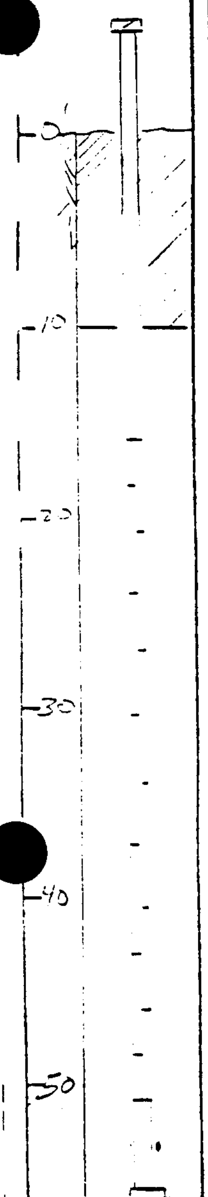
MISCELLANEOUS:

Bottom cap, vented top cap, painted flourescent green, metal tag w/number designation

W.L.
5/24/85 Dry
7/16/85 Dry

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COOR. DATES ______ ELEVATION GROUND LEVEL 5288.4

TOP OF CASING 2.92' A.G.L.

7-4

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 56

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon, california, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	4/29/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	16	C
16	51	S
51	56	C

CASING:

MATERIAL PVC

DIMENSIONS 1 1/2" bolted glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1 1/2"

SLOT SIZE ± 1/16" x 1 1/2" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, vented top cap, painted fluorescent green, metal tag w/number designation

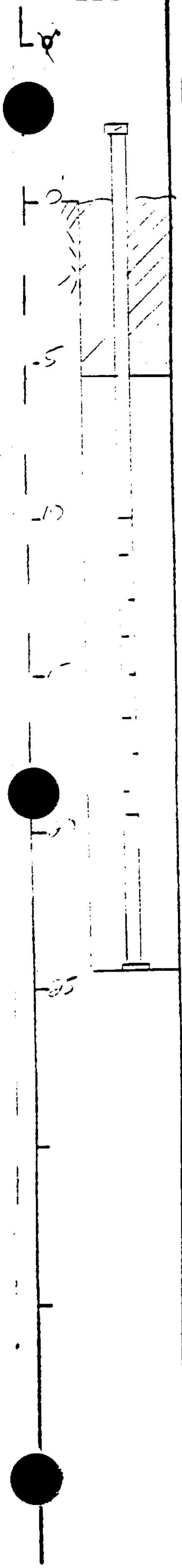
W.L.

4/29/85 18.5

7/16/85 10.94

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ________ 7-5

ELEVATION GROUND LEVEL 52.99
TOP OF CASING 3.10' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 24

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 6" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, california grab.

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/15/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 10	C	
10 – 19	S	
19 – 24	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 6'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 6'

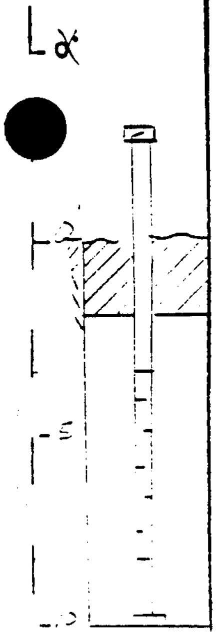
MISCELLANEOUS:

Bottom cap vented top cap
painted flourescent green
metal tag w/ number designation

WL
5/15/85 9.5'
7/16/85 7.21'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ____ 7-6A

ELEVATION GROUND LEVEL 5307.4

TOP OF CASING 2.95' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 10'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 4" continuous flight auger

DRILLING FLUID None

SAMPLING METHOD split spoon cal. [illegible] grab in test hole 7-6

SURFACE CASING

COMMENTS (problems, shutdowns, etc.) Test hole 7-6 not completed w/ PVC

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	4/24/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing; S = screen

0	3.5	C
3.5	8.5	S
8.5	10.0	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled [illegible]

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 2'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 2'

MISCELLANEOUS:

Bottom cap, vented top cap, painted florescent green, metal tag w/ number designation

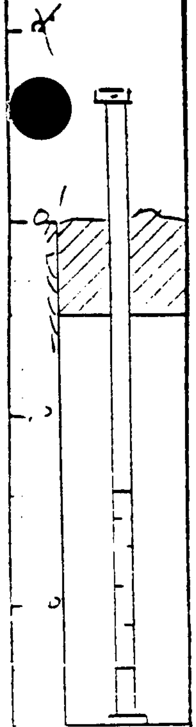
WL

4/24/85 Dry

7/16/85 6.33'

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ ELEVATION: GROUND LEVEL 5297.3

TOP OF CASING 2.74' A.G.L.

8-1

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 26.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon, California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	5/21/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	-	14.1	C
14.1	-	23.6	S
23.6	-	26.5	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 5'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 5'

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

Bottom cap, vented top cap, painted florescent green, metal tag w/ number designation

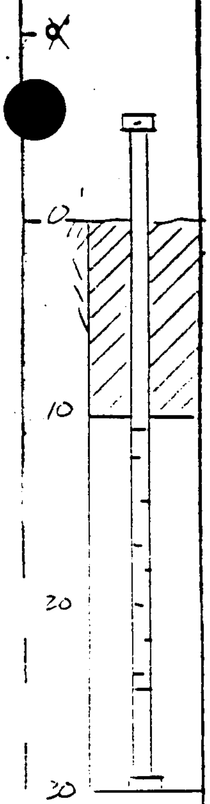
W.L

5/21/85 Dry

7/16/85 Dry

WELL CONSTRUCTION SUMMARY

SKETCH of WELL



LOCATION or COORDINATES ______ ELEVATION: GROUND LEVEL 5288.7

TOP OF CASING 3.00' A.G.L.

8-2

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 30'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon california, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	5/15/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ____ Geophysical Log ____

CASING STRING: C = casing; S = screen

0 – 11	C	
11 – 25	S	
25 – 30	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, vented top cap, painted flourescent green, metal tag w/number designation

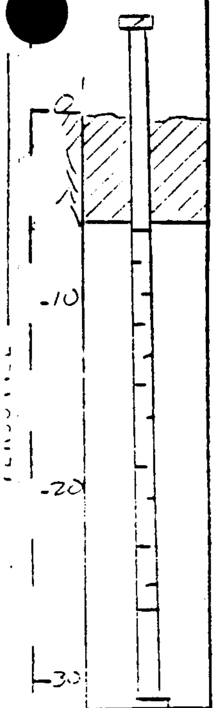
W.L.

5/15/85 13.5

7/16/85 9.31

SKETCH of WELL

0'



WELL CONSTRUCTION SUMMARY

LOCATION or COOR. DATES ______ ELEVATION GROUND LEVEL 5292.6

TOP OF CASING 2.96' A.G.L

8-3A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 31.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon california [illegible]

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.) Test hole 8-3 abandoned couldn't get pipe to stay down when pulling auger backfilled hole

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/24/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0	6.5	C
6.5	26.5	S
26.5	31.5	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 6'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 6'.

MISCELLANEOUS:

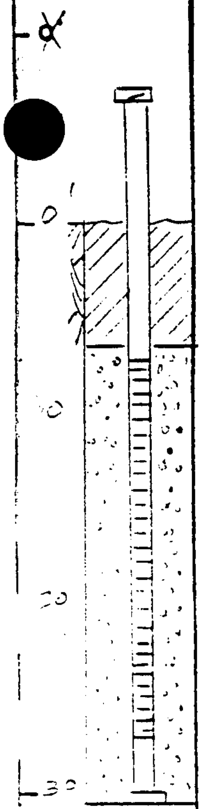
bottom cap, vented top cap, painted florescent green, metal tag w/number designation

W.L.

5/24/85 7.5'

7/16/85 5.74

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ________

ELEVATION: GROUND LEVEL 5292.6

TOP OF CASING 3.09' A.G.L.

8-3B

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 30.5'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)
Did not use #16-30 Silica sand to gravel pack fear of sticking casing inside auger. used natural sand material. Hole caved back to 6'

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	Jul 85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD Bailer surge block

ADDITIVES None

RESULTS ________

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 7.5	C	
7.5 – 27.5	S	
27.5 – 30.5	C	

CASING:

MATERIAL PVC

DIMENSIONS 2" Flush Joint Threaded

SCREEN:

MATERIAL PVC

DIMENSIONS 2"

SLOT SIZE 20

PACKERS None

CENTRALIZERS None

GRAVEL PACK Natural sand pack 30 to 6' B.G.L.

CEMENT Bentonite 0-6'

MISCELLANEOUS:

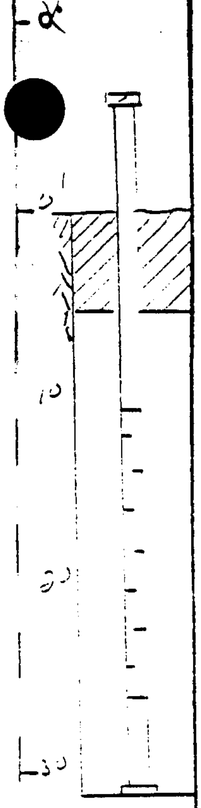
Bottom cap, vented top cap painted fluorescent green, metal tag w/ number designation

W.L.

6/11/85 8'

7/16/85 5.57

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ 8-4

ELEVATION: GROUND LEVEL 5300.3

TOP OF CASING 3.03' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 31.5

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, california, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/16/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing; S = screen

0 – 11.0	C	
11.0 – 26.0	S	
26.0 – 31.5	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 5.5'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 5.5'

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

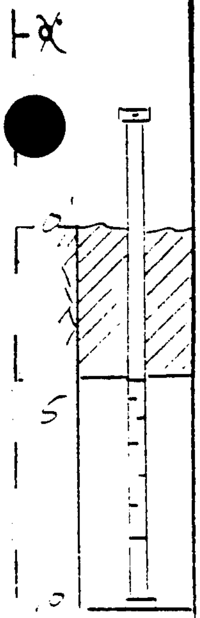
Bottom cap, vented top cap, painted fluorescent green, metal tag w/ number designation

WL

5/16/85 7'

7/16/85 7.33'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COOR. DATES ____________ ELEVATION GROUND LEVEL 5300.3

TOP OF CASING 3.00' A.G.L.

8-4A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 10'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD California, grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/12/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 – 4.0	C	
4.0 – 8.3	S	
8.3 – 9.3	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

MISCELLANEOUS:

Bottom cap, vented top cap

painted fluorescent green

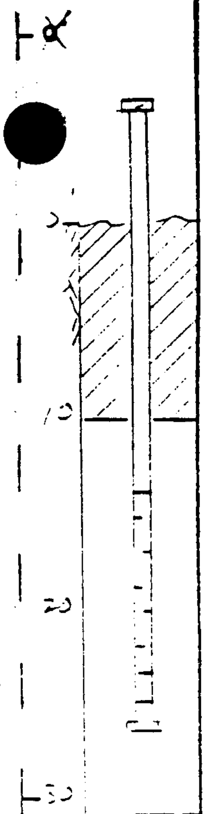
metal tag w/ number designation

WL

6/12/85 6.3'

7/16/85 7.31'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ ELEVATION: GROUND LEVEL 5318.8'

TOP OF CASING 2.87' A.G.L.

8-6

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 31'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE(S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon California grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/31/85			
LOGGING				
CASING	6/1/85			
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 14	C
14 - 25	S
25 - 31	C

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

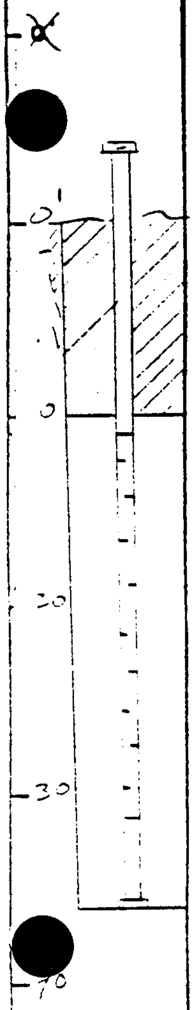
Bottom cap, vented top cap, painted fluorescent green, metal tag w/ number designation

W.L.

5/25/85 19'

7/16/85 20.03'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ____________ 8-7

ELEVATION: GROUND LEVEL 5307.9

TOP OF CASING 3.10' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 36

DRILLING CONTRACTOR Geotechnic Exploration Co

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 2" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon, California, crab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING	5/15/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 11	C	
11 - 31	S	
31 - 36	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'.

MISCELLANEOUS:

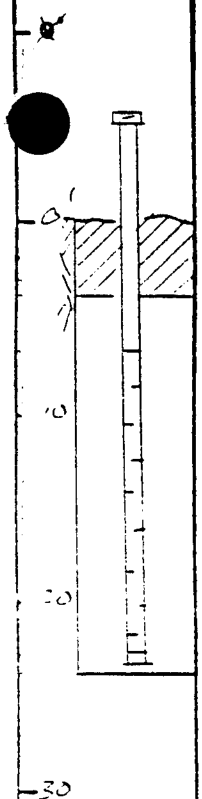
Bottom cap, vented top cap, painted fluorescent green, metal tag w/ number designation

W.L

5/15/85 11'

7/16/85 4.78'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ ELEVATION: GROUND LEVEL 5307.9

TOP OF CASING 3.10' A.G.L.

8-7A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 24'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split spoon California, grab.

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/15/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ____ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 7	C	
7 - 23	S	
23 - 24	C	

CASING:

MATERIAL Fiberglass

DIMENSIONS 2.35" Flush Joint, Threaded

SCREEN:

MATERIAL Fiberglass

DIMENSIONS 2.35"

SLOT SIZE ±1/16" x 1½" saw cut

PACKERS plastic funnel @ 4'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 4'.

MISCELLANEOUS:

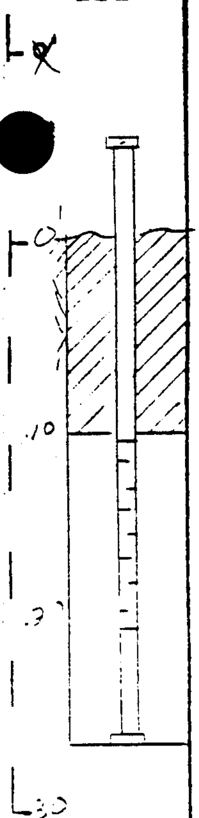
Bottom plug, vented top cap, painted fluorescent green metal tag w/ number designation

WL

5/15/85 11'

7/16/85 4.78'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ 8-8

ELEVATION: GROUND LEVEL 5305.4

TOP OF CASING 2.81' A.G.L.

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 26.5

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID Clean water

SAMPLING METHOD split spoon california grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	5/23/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

0 - 10.5	C	
10.5 - 20.5	S	
20.5 - 26.5	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

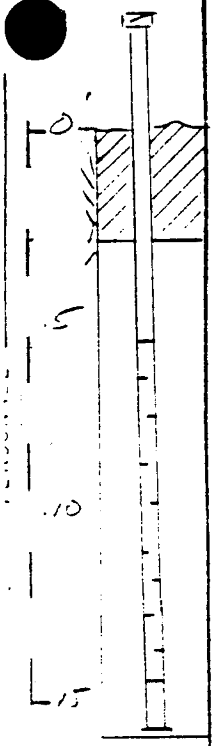
Bottom cap, vented top cap, painted florescent green, metal tag w/ number designation

W.L

5/23/85 13'

7/16/85 8.97'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ ELEVATION: GROUND LEVEL 5305.4'
TOP OF CASING 2.66' A.G.L.

8-8A

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 16'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD grab, clutch barrel

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	6/13/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ___

CASING STRING: C = casing ; S = screen

0 – 5.6	C	
5.6 – 14.6	S	
14.6 – 16.0	C	

CASING:

MATERIAL PVC

DIMENSIONS 3/4" bolted, glued

SCREEN:

MATERIAL PVC

DIMENSIONS 3/4"

SLOT SIZE ± 1/16" x 3/4" saw cut

PACKERS plastic funnel @ 3'

CENTRALIZERS None

GRAVEL PACK None

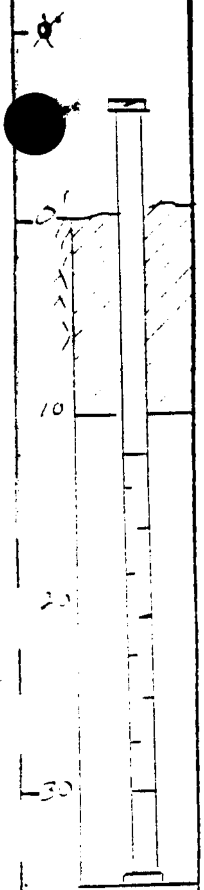
CEMENT Bentonite 0 to 3'

MISCELLANEOUS:

Bottom cap vented top cap
painted florescent green
metal tag w/ number designation

W.L.
6/13/85 10.7'
7/16/85 9.24'

SKETCH of WELL



WELL CONSTRUCTION SUMMARY

LOCATION or COORDINATES ______ ELEVATION GROUND LEVEL 5320.1

TOP OF CASING 3.16' A.G.L.

8-9

DRILLING SUMMARY:

TOTAL DEPTH DRILLED 35'

DRILLING CONTRACTOR Geotechnic Exploration Co.

RIG (S) USED CME 55

SIZES (S) and TYPE (S) of BITS 8" hollow auger

DRILLING FLUID None

SAMPLING METHOD split-spoon California grab

SURFACE CASING None

COMMENTS (problems, shutdowns, etc.)

TIME LOG:

	START DATE	START TIME	FINISH DATE	FINISH TIME
DRILLING	4/29/85			
LOGGING				
CASING				
GRAVEL PACKING				
CEMENTING				
DEVELOPMENT				
OTHER:				

DEVELOPMENT:

METHOD None

ADDITIVES None

RESULTS

WELL DESIGN:

BASIS: Geologic Log ✓ Geophysical Log ____

CASING STRING: C = casing ; S = screen

2 - 12	C	
12 - 30	S	
30 - 35	C	

CASING:

MATERIAL PVC

DIMENSIONS 1½" belled glued

SCREEN:

MATERIAL PVC

DIMENSIONS 1½"

SLOT SIZE ± 1/16" x 1½" saw cut

PACKERS plastic funnel @ 10'

CENTRALIZERS None

GRAVEL PACK None

CEMENT Bentonite 0 to 10'

MISCELLANEOUS:

Bottom cap, slotted top cap
painted fluorescent green
metal tag w/number designation

W.L.
4/29/85 18.5'
7/16/85 18.29'